KINGMAN AREA
MASTER DRAINAGE PLAN

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BOYLE ENGINEERING CORPORATION

consulting engineers / architects

PREFACE

In March 1987 the City of Kingman contracted with Boyle Engineering Corporation to prepare a Master Drainage Plan for the greater Kingman Area. The work was to include a Drainage Design and Administrative Manual, A Master Drainage Plan, a more detailed analysis of the Bull Mountain Drainage Basin, and an Executive Summary of the entire project.

The results of the study are presented in the following documents:

Executive Summary	
Master Drainage Plan	
Appendices - Volume 1	Hydrology/Hydraulic Details
Appendices - Volume 2	Bull Mountain Basin Southeast Area Drainage
Design and Administrative Manual	

This document is the Master Drainage Plan.

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1. INTRODUCTION

The City of Kingman and surrounding environs (Figure 1.1) has developed without full consideration to the drainage needs of the area. This has resulted in public inconvenience and flood damage to both public and private property. To guide future development and mitigate flooding in existing areas, City of Kingman and Mohave County officials identified the need for a comprehensive Master Drainage Plan. This Plan, accompanied by a Design and Administrative Manual, would serve as the primary administrative tool for drainage within the City of Kingman corporate limits and adjacent unincorporated areas of Mohave County.

In March 1987, the City contracted with Boyle Engineering Corporation to prepare:

1. A Master Drainage Plan for the greater Kingman area.
2. A Drainage Design and Administrative Manual.
3. New aerial mapping for selected areas.
4. A Drainage report on the Bull Mountain Basin.

The aerial mapping has been submitted under separate cover and the remaining items are included with this submittal. This report, "Kingman Area Master Drainage Plan" fulfills the requirements of item 1 and specifically includes:

1. The study procedure.
2. A description of the existing conditions.
3. The basis of design.
4. Alternative considerations.
5. Proposed improvements
6. Planning cost estimates
7. Implementation

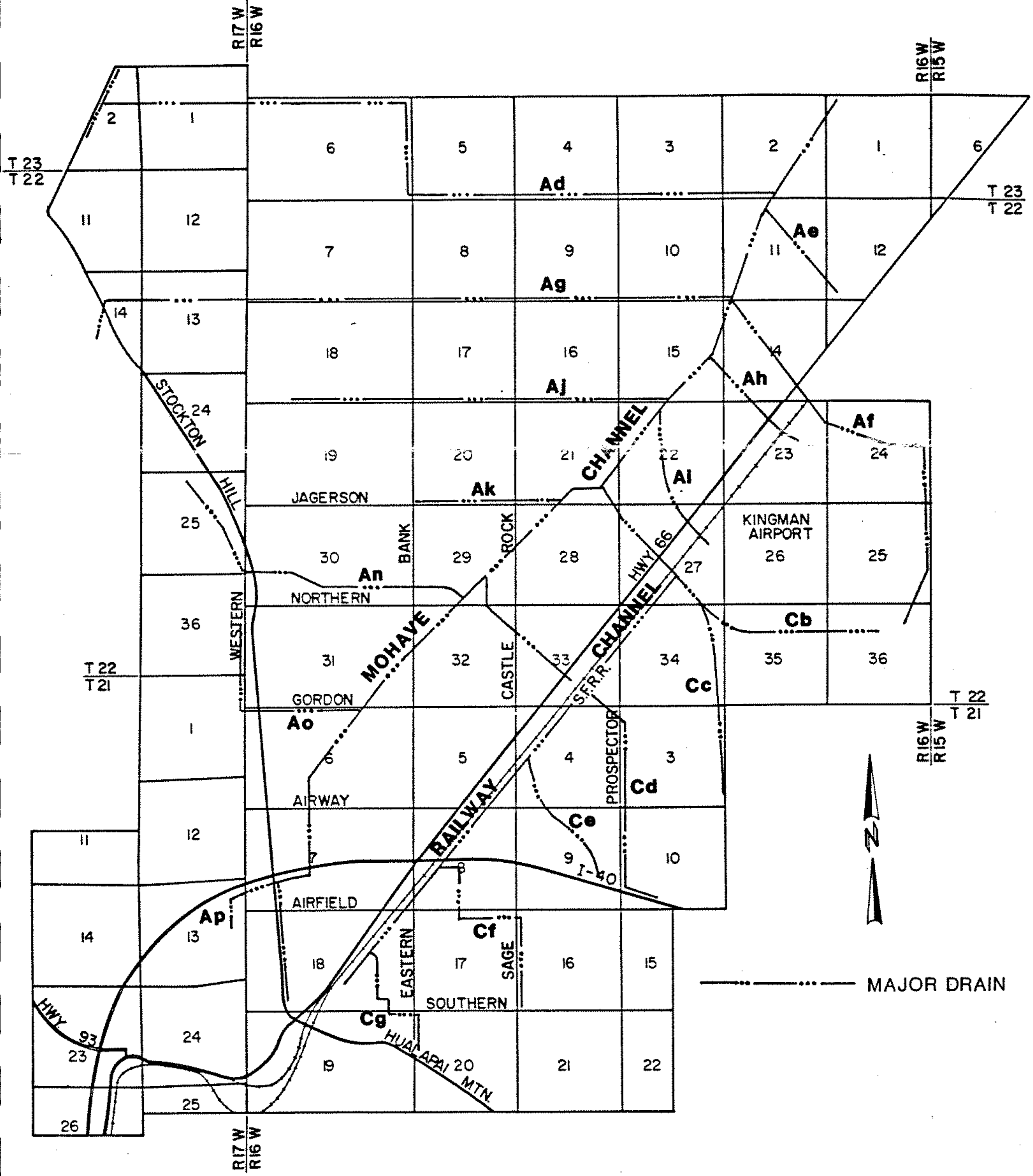

Figure 1.1 Study Area

2. STUDY PROCEDURE

The development of this Master Drainage Plan has been part of a larger, comprehensive drainage planning effort involving the coordination and integration of several related components. This section discusses some of the related components with further detail presented in subsequent sections.

Throughout the entire master planning process, ongoing communication with the City of Kingman and Mohave County has been maintained. The result is a plan which is responsive to the various needs and incorporates local knowledge to the greatest extent possible.

2.1 DRAINAGE DESIGN AND ADMINISTRATIVE MANUAL

A Drainage Design and Administrative Manual was prepared as part of the comprehensive drainage planning effort for the Kingman area. The Manual provides direction and specifies requirements for the evaluation and design of drainage facilities. It also presents drainage policies which are intended to establish a framework for future development. The Manual contains drainage policies, procedures for hydrologic and hydraulic studies and requirements for submissions to the appropriate reviewing agency. A draft of this Manual was prepared and submitted to the City and County for their review and comment.

Subsequent to initial City and County review of the Manual, the draft version was distributed to Soil Conservation Service staff and the local engineering community. After their review, a meeting was convened which focused on drainage policies that affect drainage planning and design. Using the information obtained during this meeting, the Manual was modified and resubmitted for adoption by the City and County.

2.2 AERIAL MAPPING

Updated aerial photography and topographic mapping to a scale of 1" = 200' with 2' contours was developed for selected areas. These areas were agreed on with the City/County prior to commencing work. The new mapping included the Mohave Channel to the limits of the study area. The combination of existing and new mapping covered most of the proposed new major drainageways and were used to establish invert elevations and grades. An index of the available maps is presented in Figure 2.1.

For consistency in plan presentation, an updated aerial map to a scale of 1" = 800' was prepared to cover the entire study area. This plan was used for base sheets in the alignment plans presented later in this report.

2.3 BULL MOUNTAIN STUDY

A detailed drainage study was prepared for the Bull Mountain area to address drainage problems resulting from roadway improvements proposed along Stockton Hill Road. The Bull Mountain Basin Drainage Report is a prototype for this Master Drainage Plan. The drainage report included hydrologic evaluations of the watershed, hydraulic analysis of the proposed channel and Stockton Hill Road crossing. Plan and profile drawings of the recommended improvements were also included.

The roadway improvements proposed along Stockton Hill Road, as a result of the detailed drainage study, includes a box culvert crossing. The detailed plans and specifications for the construction of the box culvert crossing are based on the findings presented in the Drainage Report.

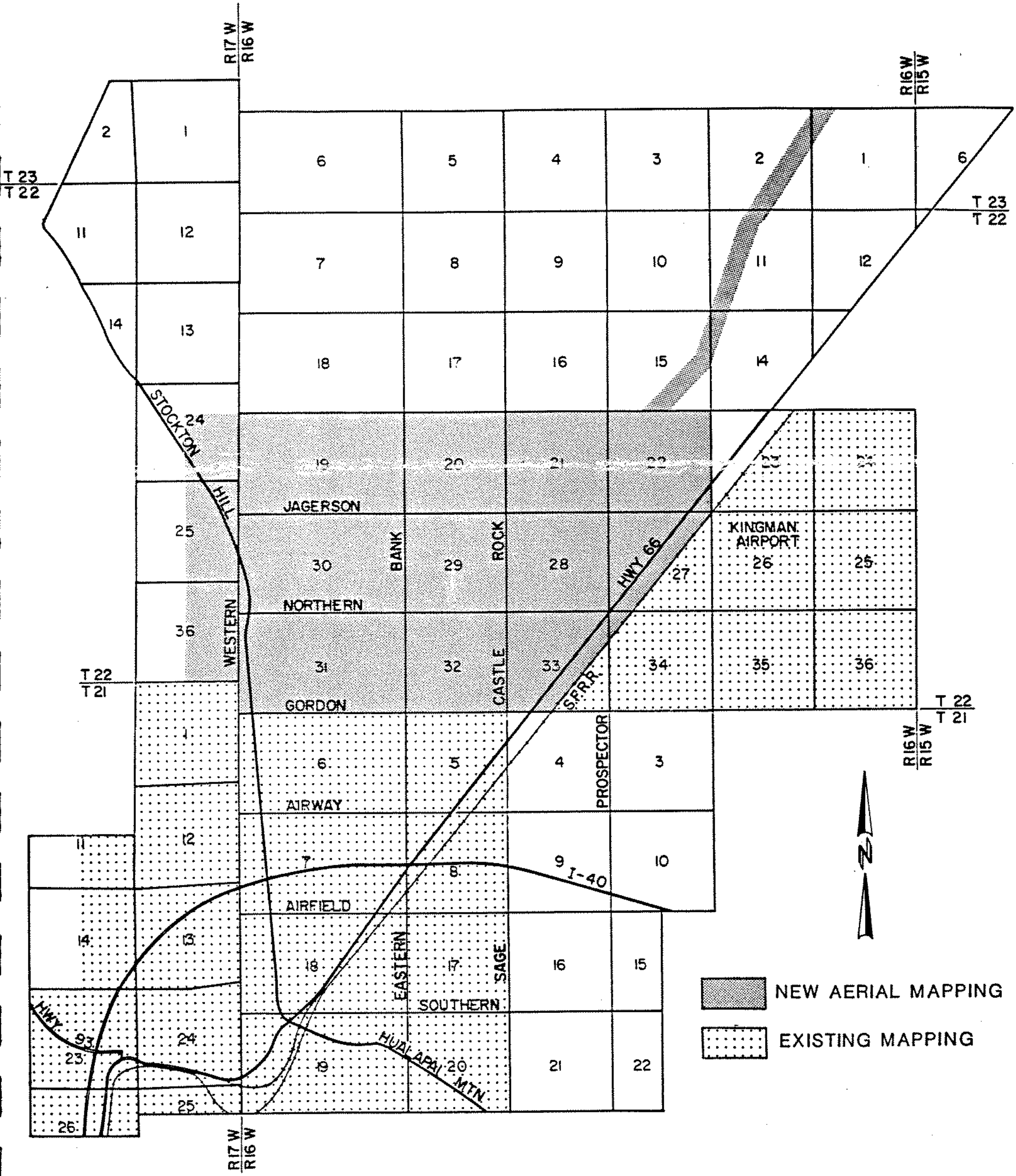

Figure 2.1 Aerial Mapping Index

2.4 LAYOUT OF MAJOR DRAINS

One of the initial steps in the planning effort was the designation of major drains and the development of provisions for the design, construction and maintenance of the drains. The designation of the drains was based on the criteria set forth in the Design and Administrative Manual. Subsequent to the designation of the major drains, a plan for the responsibility for design, construction and maintenance was developed and submitted to the City and County for their review and approval. The major drains depicted on Figure 1.1, and presented in more detail in later sections, have been agreed upon by the City and County.

2.5 FIELD REVIEW OF FLOODING AREAS

Field review of historic flooding areas was an early component of the drainage planning effort. This, in conjunction with topographic mapping and hydrologic analysis, were the necessary elements in the understanding of drainage problems and the development of practical solutions to flooding.

The field reviews included a visual investigation of the upstream watershed, identification of existing drainage facilities and review of evidence of historic flooding and flood related problems such as deposition or scour. During the reviews, alternatives for the solution of flooding problems were identified and discussed with City staff. The resulting proposed drainage works presented in this report incorporates the developed findings.

3. EXISTING CONDITIONS

Existing problems, and primarily those anticipated as a result of future development, have necessitated this Master Drainage Plan. Many of the existing problems are the result of high runoff and inadequately sized, or nonexistent, drainage facilities. These existing problems can be corrected, and future problems averted, only after a thorough understanding of the existing conditions within the study area.

3.1 STUDY AREA

The study area shown on Exhibit 1 contains 72 square miles. There are two major drainage basins that contribute runoff to the study area. They are the Mohave Channel basin which drains to the north and the Johnston Canyon Basin which drains to the south.

The Mohave Channel basin has a drainage area of 168 square miles and extends to the Cerbat Mountains on the west and the Hualapai Mountains on the south and east. The upper reaches of the basin are mountainous with slopes in excess of 35 percent. Alluvial fans characterize the land form from the base of the mountains to the Mohave Channel with overland slopes ranging from 2 to 4 percent.

Johnston Canyon basin has a drainage area of 12 square miles within the study area and has its headwaters in the Cerbat Mountains. It includes the developed downtown area. The general land form is steep with large rock outcrops.

3.2 SOILS

Soils within the study area can be divided into three regional groups: mountains, alluvial fan, and the Mohave Channel. The general delineation of the hydrologic soil classifications is presented in Figure 3.1.

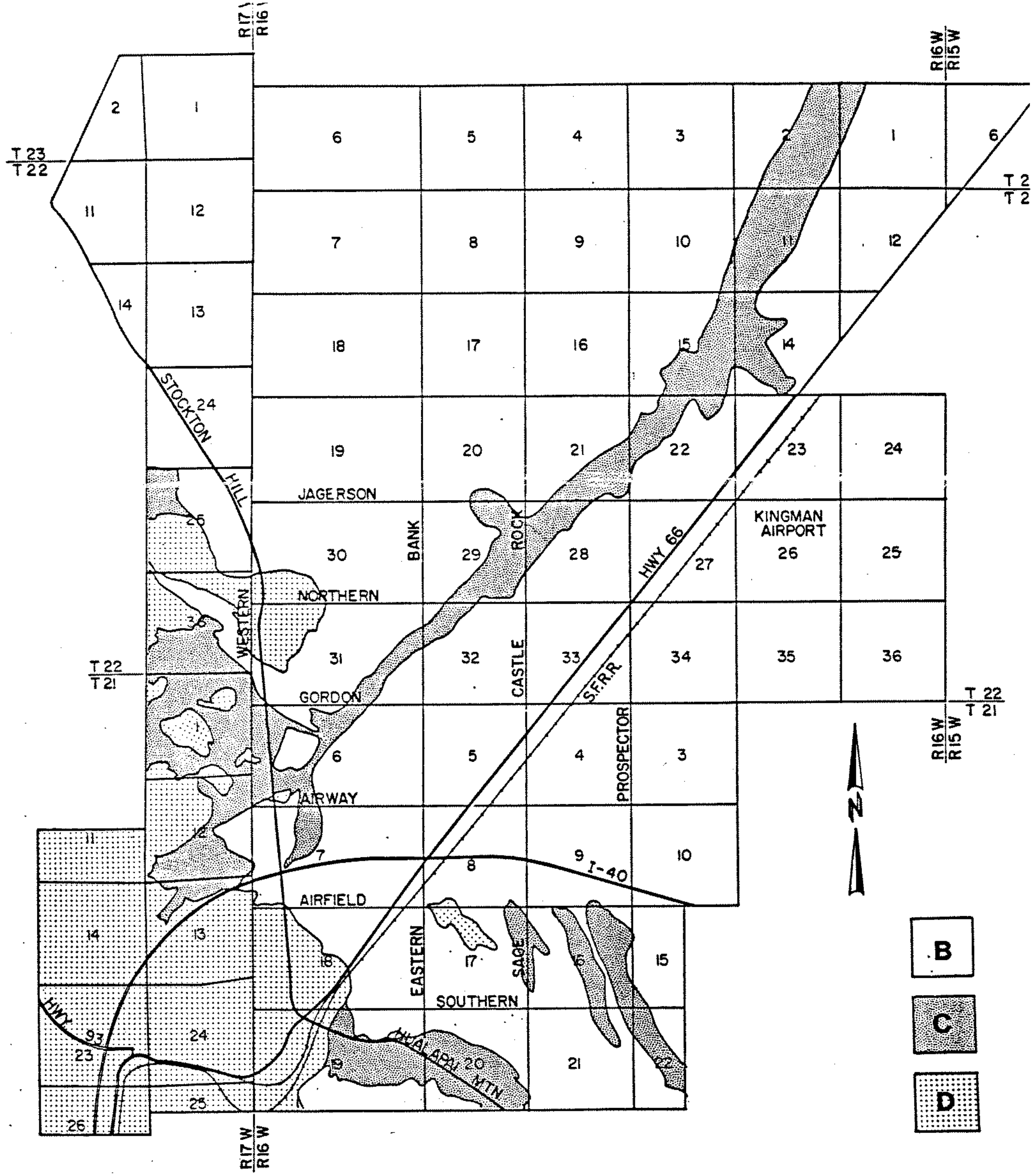

Figure 3.1 Hydrologic Soil Groups

Soils in the mountains consist of rock outcrops and shallow, well-drained soils of the Akela Series. The Soil Conservation Service (SCS) has established the Akela Series as falling into hydrological soil classification D.

The alluvial fan, which covers most of the study area, consists of two predominant soil types. The first is the Whitehills Series which is a moderately deep deposit of sandy and clay loam overlying hardpan at about 4 feet. The second is the Pajarito Series which consists of deep, well-drained fine sandy loam. The SCS hydrological soil classification for the Whitehills Series is C and B for the Pajarito Series.

The remaining soil type, the Glendale Series, is located in or near the Mohave Channel. It contains deep, well-drained soils typical of flood plains. The hydrological soil classification for this series is C.

3.3 DEVELOPMENT

The estimated population of the study area is 23,500 of which about 11,600 live within the City of Kingman. New development is primarily on the alluvial fans of the Mohave Channel Basin west of Andy Devine Avenue. Development is also taking place east of Andy Devine Avenue and south of I-40, in the vicinity of Hualapai Mountain Road.

Commercial development is generally along both sides of Andy Devine Avenue, Stockton Hill Road, Beale Street and Northern Avenue. Industrial land use is predominant in the area surrounding the Kingman Municipal Airport. The remainder of the development consists of residential, public lands and open space, with residential development accounting for the majority of the total.

3.4 EXISTING DRAINAGE SYSTEM

Drainage within the study area is primarily by overland sheet flow, natural or improved drainageways, and by street networks. Improved channels include about 1.5 miles of storm drain in Stockton Hill Road, a short drainage channel running parallel to I-40 and unlined open channels draining into the Mohave Channel near Northern Avenue. With the exception of a few culverts, mostly along the major arterial streets and downtown, road crossings are generally dipped sections.

3.4.1 Mohave Channel Basin

Runoff in the Mohave Channel Basin from the Hualapai Mountains to the east is restricted by the Atchison Topeka & Sante Fe Railroad (AT&SF) and US-66. Several culverts have been constructed under the railroad that have concentrated flows. In many cases this has resulted in downstream flooding due to inadequately sized outlet facilities.

The culverts presently limit the passage of flows from upstream and reduce the impact of runoff from the east. The culverts are upgraded by the AT&SF as upstream development takes place which further increases downstream flooding problems.

Runoff from the Cerbat Mountains in the west travels swiftly, transporting sediment and boulders in defined washes. Further downstream, as runoff flows onto the alluvial fan, velocities decrease and washes tend to be laterally unstable. At Stockton Hill Road, flatter ground slopes have resulted in the deposition of sediment and boulders. Runoff then continues across Stockton Hill Road in dipped cross sections down to the Mohave Channel.

Within the Mohave Channel Basin, the FEMA has designated the Mohave Channel and surrounding area to be in the 100-year shallow flooding zone or Zone AH. The remainder of the alluvial fan lies in the zone of minimal flooding, or Zone C.

3.4.2 Johnston Canyon Basin

Runoff from the downtown area of Kingman flows to the south crossing Andy Devine Avenue and the Atchison, Topeka and Santa Fe Railroad and enters Holy Moses Wash. As in the Mohave Channel basin, the existing crossings limit the impact on downstream lands. Development upstream of the railroad is almost complete and should not aggravate downstream conditions.

Flow generated west of I-40 in Clack and Johnston Canyons cross I-40 and US-93 and leave town in generally well defined natural drainageways. Upland areas within these drainageways are rugged and not well suited to future development.

3.5 EXISTING PROBLEM AREAS

Following discussions with City personnel and field investigations, several areas of flooding were identified.

3.5.1 Downtown Area Problems (Reference Figure 3.2)

Streets in the downtown area are wide with high curbs and are generally adequate to handle storm runoff; however, the following areas experience frequent flooding:

1. First Street and Andy Devine Avenue - Flows from side streets north of Andy Devine Avenue combine with the street flow in Andy Devine Avenue and pond at First Street. There is a single grated outlet in the street which is inadequate to drain the area. The intersection is frequently impassable during storms.

2. Eighth Street Underpass at the AT&SF Railroad - Runoff from upstream of Eighth Street, including flows originally in Powderhouse Canyon, flow west along the railroad and pond in the underpass. A small pipe and channel which drain the underpass are undersized and require frequent maintenance.

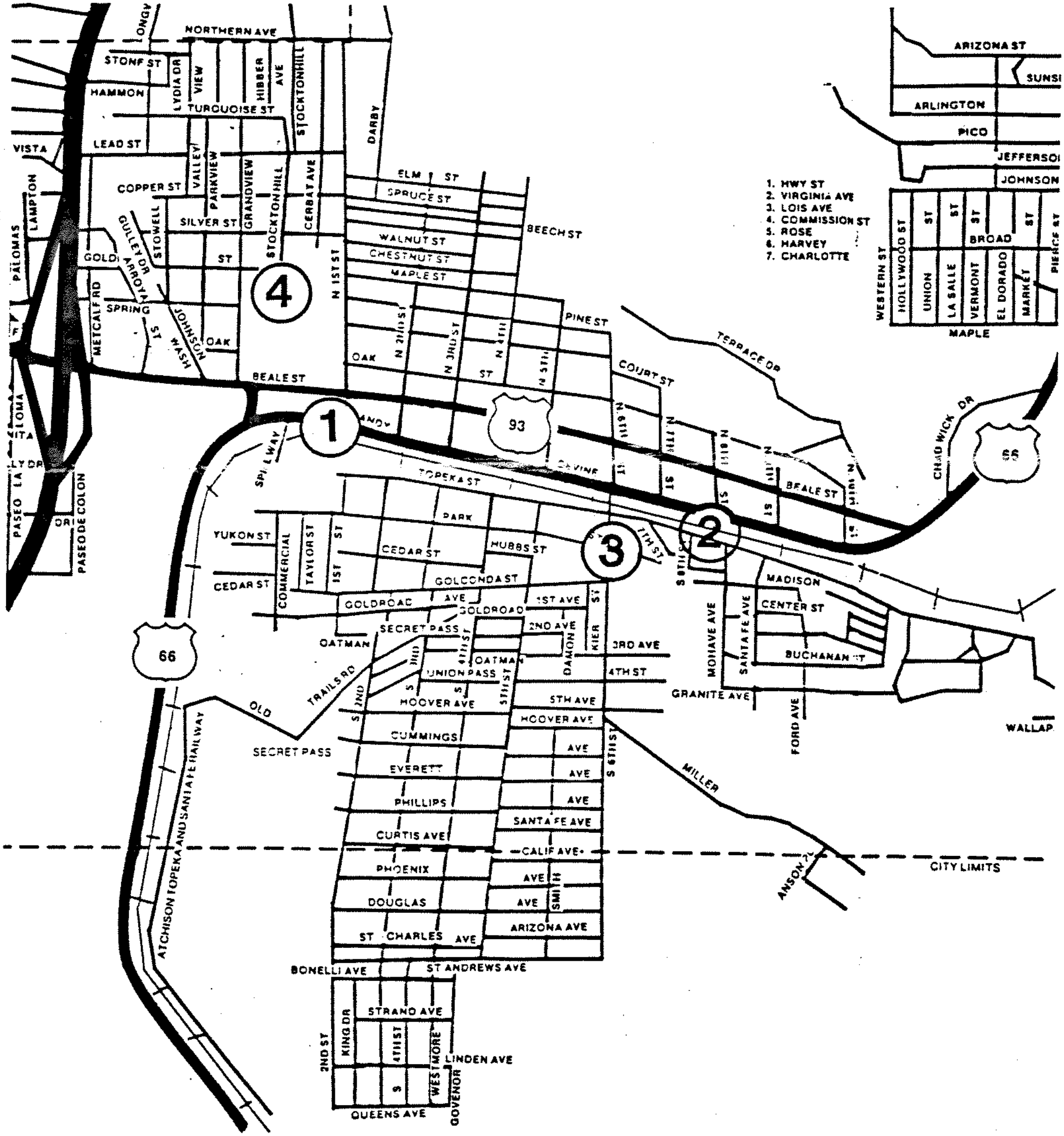

Figure 3.2 Downtown Flooding Areas

3. Sixth Street south of the AT&SF Railroad - During heavy storms, floodwaters reach Park and Golconda Streets then continue south west and flood the S&S Apartments at Old Trails Road and Golconda Street. The City has recently developed the upstream area as a grassed park which may alleviate some future flooding.

4. High School - Stockton Hill Avenue carries flow from an upstream wash to Silver Street where it enters the high school parking lot. An existing drain in the parking lot is not properly located and stormwater bypasses the drain and continues to the athletic field south of the high school. The runoff eventually exits the athletic field via a drain under Andy Devine Avenue.

3.5.2 Mohave Channel Basin Problems (Reference Figure 3.3)

The flooding problems in the Mohave Channel basin generally occur at points of concentration of runoff at AT&SF Railroad culverts where no adequate downstream drainage facilities exist; along Stockton Hill Road from runoff from the Cerbat Mountains and other miscellaneous nuisance flooding.

1. Fairgrounds Boulevard - Runoff from east of AT&SF Railroad and contributing adjacent side streets flows down Fairgrounds Boulevard to the County Fairgrounds. There are currently no drainage facilities to manage the runoff.

2. Bank Street - Bank Street is the drainage system for a large area east of the railroad and adjacent side streets. At present the capacity of the railroad culvert limits the 100 year runoff to 1500 cfs with the current 10 year runoff being about 800 cfs. These high flows frequently and severely flood Bank Street. The floodwaters eventually find their way to the Mohave Channel.

3. <u>Stockton Hill Road</u> - Runoff from the Cerbat Mountains frequently floods a number of locations along Stockton Hill Road. The most serious is in the vicinity of Gordon Drive. The Bull Mountain Drainage Report specifically addressed this problem.

4. <u>Sunrise and Western Avenue</u> - Runoff from the mountain behind the golf course together with increased runoff from new development is creating problems in this area.

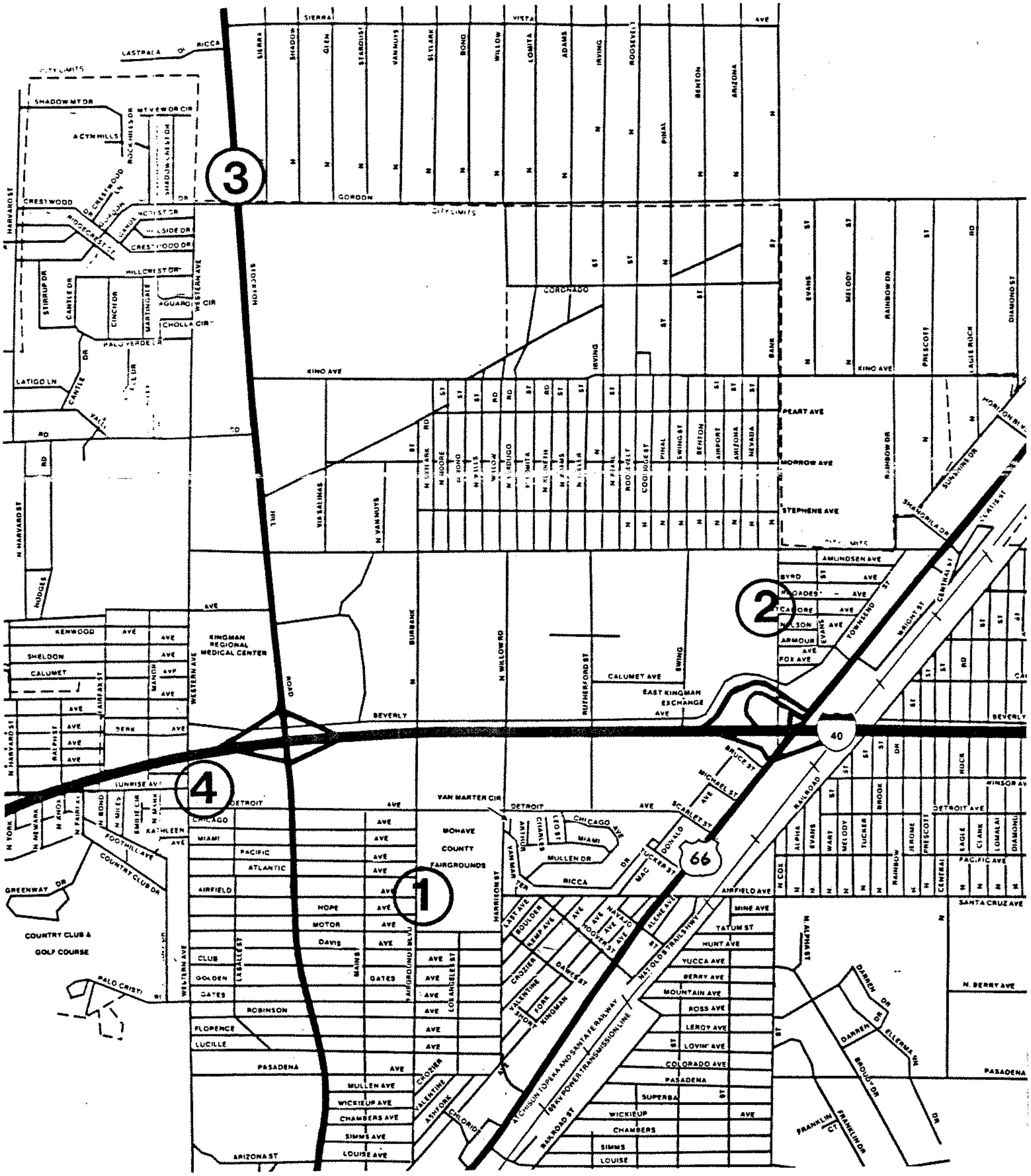

Figure 3.3 Mohave Channel Basin Flooding Areas

4. BASIS OF DESIGN

This section presents the approaches adopted during the development of the Master Drainage Plan and identifies general assumptions made during the course of the studies. The Plan has been prepared in accordance with the Drainage Design and Administrative Manual prepared early in the study.

4.1 LEVEL OF PROTECTION

Major drainageways identified have been sized to convey the 100 year runoff without overtopping. Drainage problems within existing development vary and are site specific and no generic level of protection or type of solution is proposed.

4.2 AVAILABLE DATA

Numerous documents and data have been collected and reviewed during the development of the plan. Many general references were also used. The following list contains some site specific documents used in this study:

- Kingman Area Drainage Design and Administrative Manual (Boyle 1987)
- Bull Mountain Basin Drainage Report (Boyle 1987)
- Southeast Area Conceptual Alternative Layout (Boyle 1987)
- Aerial Topographic Mapping (Kenny Aerial 1987)
- Other Aerial Maps
- USGS 7-1/2 Minute Quadrangle Maps
- Flood Insurance Study Mohave County, Arizona (FEMA 1986) and City of Kingman, Arizona (FEMA 1977)
- City of Kingman Codes and Ordinances
- Maps of existing Right-of-Way provided by City Staff
- As-built Drawings of road, sewer and water improvements

- SCS Soil Survey Special Report for Parts of Mohave County, dated 1980 and extended in 1987
- City of Kingman General Plan for 1990 (Wilsey & Ham, 1971)
- Kingman Area Transportation Study, (Parsons Brinckerhoff August 1987)

4.3 HYDROLOGIC ANALYSIS

The hydrologic evaluation of the Kingman area was performed using the SCS Method within the U.S. Army Corps of Engineers (COE) Flood Hydrograph Package (HEC-1). Hydrographs were generated for the 2, 10 and 100-year storms. The delineation of subbasins (Exhibit 2) and the development of basin characteristics were obtained from available topographic maps and soil surveys.

The rainfall distribution chosen for this study was a 3-hour distribution based on the Indio (California) area thunderstorm of September 24, 1939. This has been adopted by the Riverside County Flood Control District and provides a realistic representation of actual rainstorms in the Kingman area. Point precipitation values were obtained from published data for the Kingman Gage. For the 3 hour storm they are 1.05 inches (2 year), 1.78 inches (10 year) and 2.83 inches (100 year).

Areal reduction factors were applied to point rainfall values in accordance with the procedures presented in the NOAA Atlas for Arizona. They ranged from 1.0 (no decrease in total rainfall depth) for very small drainage basins to .81 for the entire study area.

The SCS basin lag was determined by multiplying the COE lag by 78 percent. Routing of the resulting hydrographs was performed using the kinematic wave option in HEC-1.

The details of the hydrologic analysis are presented in Appendix A. This Appendix contains summary tables on the subbasin hydrology data, the channel routing data and the runoff adjustments for area.

4.4 HYDRAULIC ANALYSIS

The hydraulic evaluation for channels within the study area was accomplished using STORMPLUS a proprietary modification of the Los Angeles County Water Service Profile Computer Program. This program calculates water surface profiles, and other hydraulic characteristics for either subcritical or supercritical flow. A starting water surface elevation is assumed, and using energy and momentum principals, a backwater profile is calculated. To test for the possibility of supercritical flow, the profile is also calculated in the downstream direction.

The water surface profile computer program requires the input of peak flow data, channel geometry, slope, roughness, and starting water surface elevations. The channels adopted are earthen lined trapezoidal sections with three horizontal to one vertical side slopes with a roughness coefficient of 0.030.

The details of the hydraulic analysis are presented in Appendix B for the 100 year storm and Appendix C for the 10 year event.

4.5 SEDIMENTATION AND SCOUR

Within the Kingman area sediment is generated in the upland headwaters, transported to the base of the mountains and deposited on the alluvial fan. Scour occurs along the channels in the mountains and at scattered locations on the fan. Development on the fan alters the historic characteristics of the sedimentation and scour.

East of the AT&SF Railroad, the distance between the Hualapai Mountains and the study area minimizes the sediment load reaching proposed improvements and in the downtown area, with steep slopes, there is little likelihood of deposition.

Along Stockton Hill Road, near the western edge of the study area, conditions are most conducive for the deposition of sediment. The total amount of material available however is limited by the relatively small drainage basin tributary to these areas. Some deposition is likely and will require routine maintenance to prevent loss of channel conveyance.

The 100 year runoff will generally flow at erosive velocities in the proposed unlined channels. Critical channel reaches where failure might pose a serious threat to life or property will be lined with concrete or soil cement. In less critical reaches where scour can be tolerated without catastrophic consequences, channels have been proposed which have low velocities during frequent storms (2-year) but will experience some scour during less frequent storms, such as the 10-year to 100-year storms.

Channel maintenance will be required after major storm events where scour occurs and is considered a more reasonable solution than to line all major drainageways. Liberal setbacks up to 100' for buildings outside of channel right-of-way will reduce the potential for major property damage. An alternative to setbacks would be embankment protection adjacent to and upstream of the property. Particular attention would have to be given to potential scour behind the protected area.

5. ALTERNATIVE CONSIDERATIONS

This chapter presents alternative drainage elements considered during the development of the final Master Drainage Plan. The alternatives were reviewed with City and County staff and infeasible options were eliminated from further consideration. Concentrated effort was then directed toward the evaluation of the preferred solution to develop the components necessary for the final Master Drainage Plan.

Five drainage elements were considered as part of this study:

1. Major Drainageway Alignment
2. Detention Storage
3. Conveyance Systems
4. Channel Crossings
5. Diversions

5.1 MAJOR DRAINAGEWAY ALIGNMENT

The alignment of major drainageways was selected based on existing alignments and new reasonably spaced drainage corridors. The proposed channels are shown in Exhibit 3.

The Mohave Channel follows the general alignment of the existing channel with minor deviations to facilitate channel shaping. For most other drains, because it was deemed infeasible to provide a major drain along every existing alignment across the alluvial fan, corridors were identified which would serve as the future location for a major drain. These corridors, near section lines, intercept flows generated on the fan above the developed areas and provide a defined outfall for adjacent developments. Establishing the designated right-of-way precludes development within the defined drainageway and provides a reliable and implementable planning tool. In areas of existing development, where channels exist, the major drainageways follow the existing alignment.

5.2 DETENTION STORAGE

Detention storage was considered as a means of reducing peak flows and the size of downstream conveyance systems. However no feasible sites were identified for this master plan.

On the east side of the valley, locating a basin at the foothills of the Hualapai Mountains is too distant to significantly reduce peak flows within the study area. Locating facilities on the fan just upstream of the study area is also considered infeasible because of the steep slopes and still required need for an outfall channel.

On the west side of the valley, basins were reviewed in conjunction with the Bull Mountain drainage study and again were found to be infeasible. This is because of the relatively wide canyons, steep valleys and underlying hardpan. To develop the necessary storage to significantly reduce downstream peak flows would require high embankments or excavation below existing ground levels in hard material.

5.3 CONVEYANCE SYSTEMS

Several conveyance systems were evaluated for use within the Kingman area. These systems were grouped into closed conduits and open channels. Closed conduits were eliminated, except in special cases because of their high cost. They are considered more practical for street drainage of minor flows.

The alternatives for open channels include narrow lined or wide unlined sections. The balance is between right-of-way cost and the cost for channel lining. It is estimated that right-of-way would have to cost at least $50,000 per acre before lined channels could be more cost effective than unlined channels. Because this is not generally the case in Kingman, no lining is proposed for most channels.

In the course of detailed design of channel improvements, a soils investigation should be carried out to establish the depth of potential hardpan. Where hardpan exists, that may reduce the need for channel protection, a narrower, deeper channel section may be more cost effective. This would need to be looked at on a case by case basis.

Some erosion may be expected during less frequent events but common events such as the 2-year flood are generally conveyed at non-erosive velocities. This alternative minimizes the capital cost of channel construction by allowing some erosion during less frequent events. This solution is considered acceptable provided it is understood that additional maintenance will be required after major storm events and liberal building setbacks are desired to safeguard against potential damage.

In some cases, a channel with a hardened lining or drop structures is proposed. In either event, the hydraulic characteristics of flow are such that channel failure at the 100-year flows is unlikely. Channels receiving this type of lining are in areas where failure would cause a threat to life or cause major damage.

5.4 CHANNEL CROSSINGS

Channel crossings are necessary where major streets cross the drainageways. Alternatives evaluated for channel crossings include providing a culvert with the capacity of the entire 100-year flow or providing a 10 year culvert capacity with street overflows capable of conveying the 100-year runoff.

It has been estimated that the cost of culverts is about $0.60/foot per cubic foot/second (cfs) conveyed. This estimate is based on the cost of multiple 6 foot high by 10 foot wide ADOT box culverts with runoff flowing at 10 feet/second.

The 100 year runoff ranges from about 2-3.5 times the 10 year runoff. This means that culverts conveying the 100 year runoff without overtopping the road will cost about 2-3.5 times the 10 year culvert. The level of protection to be afforded a particular road crossing should be based on the road importance and available funds. The decision can be made at the time of detailed design. There is sufficient hydrologic information contained in this report to aid the decision process.

For this study we have assumed culverts with a capacity to convey the 10 year storm will be constructed at section line crossings. At other roads dipped crossings are proposed which is similar to the existing condition. During final design, the evaluation of equivalent bridge sections should be investigated.

5.5 DIVERSIONS

Early in the study, alternatives were reviewed to relieve the flooding along Fairgrounds Boulevard and Bank Street. A diversion channel was proposed and agreed on along the east side of the AT&SF Railroad line extending from the Getz Station (MP 514.3) northward to a point south of the airport entrance (MP 509.1). This diversion channel will collect flows from the upstream drainage area and bypass the developed areas west of the railroad tracks. Fairgrounds Boulevard, Bank Streets and the Mohave Channel will experience the most significant reductions in storm flows. Table 5.1 estimates the peak flow reduction at key locations with and without the proposed diversion. (See Exhibit 3 for channel locations).

A report was prepared titled "Southeast Area Drainage Conceptual Alternative Layout", documenting the diversion channel proposal and submitted to the Railway authorities to seek permission to construct part of the channel on their right of way. As of May 1988 this is still under consideration. This report is contained in Appendix E.

Table 5.1 Diversion Channel Impacts on Downstream Flows

Channel Section	Runoff With Diversion (cfs)			Runoff Without Diversion (cfs)		
	2 yr	10 Yr	100 Yr	2 yr	10 yr	100 yr
90 - 80	319	1054	2144	408	1460	3287
80 - 70	712	2957	6909	949	4040	9643
70 - 60	712	3361	8364	1484	6862	17116
60 - 50	911	4784	11910	1718	8551	21316
Fairgrounds Blvd			130			500
Bank Street			200			2500

6. PROPOSED IMPROVEMENTS

The proposed improvements developed for major drains within the Kingman area are presented on Plates 1 through 40 located at the end of this report. An index is provided at the beginning of the Plates and an overview of the drainage system is given in Exhibit 3.

The improvements are primarily concerned with preventing future major damage as development intensifies on the alluvial fans. The only improvements recommended in the dowtown area is line Bb as shown on Plate 40. The design for this system is for a 2 year storm.

The design of the drainageways has been based on the contributing areas shown in Exhibit 2. It is important that future development adhere to these basin boundaries and direct their runoff to the appropriate drain. This can be accomplished by appropriate grading of lateral streets.

Table 6.1 summarizes the relevant hydrological and hydraulic details of the planned channels. The Table also contains the proposed rights-of-way and references to the relevant Plates. A typical channel section is shown in Figure 6.1.

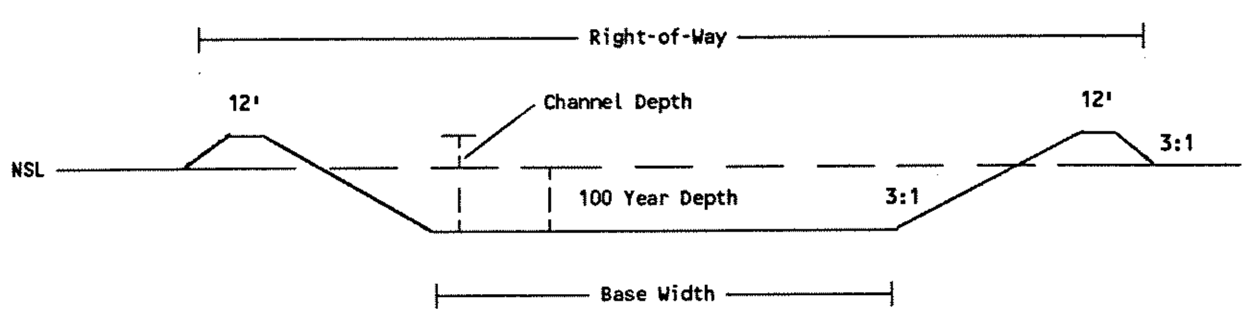

Figure 6.1 Typical Channel Section

Table 6.1 Hydrology/Hydraulics Summary

Channel	Drain	Plate Nos.	Area (sq mi)	Length (ft)	Slope (f/f)	Base Width (ft)	Channel Depth (ft)	ROW (ft)	2 YEAR Q (cfs)	2 YEAR D (ft)	2 YEAR V (f/s)	10 YEAR Q (cfs)	10 YEAR D (ft)	10 YEAR V (f/s)	100 YEAR Q (cfs)	100 YEAR D (ft)	100 YEAR V (f/s)
BASIN A																	
Mohave	10 - 20	1	167.7	6,300	.0043	700	8.1	785	1,384	.7	2.6	13,001	2.9	6.6	46,057	6.1	10.7
Channel	20 - 30	1,2	118.3	6,300	.0047	600	7.8	685	1,384	.8	2.9	11,923	2.9	6.8	37,241	5.8	10.8
	30 - 40	2	63.9	5,900	.0044	400	7.6	485	1,204	1.0	3.3	7,624	2.9	6.6	22,813	5.6	10.1
	40 - 50	2,3	58.8	5,600	.0038	400	7.8	485	1,204	1.0	3.1	7,624	3.0	6.3	22,656	5.8	9.6
	50 - 60	3	22.1	7,700	.0035	200	8.2	285	911	1.3	3.5	4,784	3.6	6.7	11,910	6.2	9.4
	60 - 70	4	15.5	1,500	.0046	150	7.5	230	712	1.2	3.8	3,361	3.1	6.9	8,364	5.5	9.9
	70 - 80	4	11.7	9,200	.0049	120	7.5	200	712	1.4	4.3	2,957	3.3	7.4	6,909	5.5	10.1
	80 - 90	5	2.6	7,900	.0057	50	6.5	125	319	1.3	4.4	1,054	2.8	6.9	2,144	4.5	9.0
	90 - 91	6	-	-	-	-		-	-	-	-	-	-	-	-	-	-
Line Ad	Ad1 - Ad2	11,12	11.8	18,400	.0145	150	5.5	220	1,074	1.1	6.3	3,061	2.1	9.6	6,971	3.5	13.3
	Ad2 - Ad3	12,13	9.3	5,200	.0084	150	5.9	220	1,074	1.3	5.4	3,061	2.4	8.0	6,373	3.9	10.8
	Ad3 - Ad4	13-15	7.5	16,000	.0226	150	4.7	215	1,074	1.0	7.4	2,887	1.8	10.9	5,722	2.7	14.1
	Ad4 - Ad5	15	3.9	2,000	.0110	80	5.4	150	662	1.3	6.1	1,638	2.2	8.5	3,139	3.4	11.0
	Ad4 - Ad6	15	.9	2,000	.0440	20	5.1	90	231	1.0	10.3	537	1.7	13.9	1,018	2.7	17.4
Line Ae	20 - Ae2	16	28.8	6,400	.0097	200	6.0	275	-	-	-	2,522	1.8	7.1	9,996	4.0	11.9
Line Af	30 - Af2	17	35.4	6,800	.0083	250	6.6	325	1,414	1.2	5.1	5,547	2.6	8.4	14,402	4.6	12.1
	Af2 - Af3	17,18	33.5	10,800	.0119	250	6.1	325	1,414	1.0	5.4	5,547	2.3	9.3	14,402	4.1	13.5
	Af3 - Af6	18	1.1	4,800	.0115	20	5.0	85	32	.5	3.5	226	1.5	6.6	622	3.0	9.4
Line Ag	30 - Ag2	19,20	9.4	20,000	.0153	100	5.7	170	657	1.0	6.1	2,200	2.2	10.1	5,319	3.7	13.9
	Ag2 - Ag3	21,22	5.9	11,000	.0203	100	5.0	170	657	1.0	7.0	2,029	1.9	10.6	4,271	3.0	14.1
	Ag3 - Ag4	22	2.5	3,900	.0041	80	5.5	150	422	1.3	3.7	1,039	2.3	5.3	1,983	3.5	6.9
Line Ah	30 - Ah2	23	2.5	7,200	.0086	50	4.8	115	97	.6	3.3	501	1.6	6.1	1,270	2.8	8.5
Line Ai	40 - Ai2	24	.8	7,400	.0068	20	5.7	90	32	.5	2.7	278	2.0	5.9	676	3.7	7.9

NOTES: 1) See Figure 6.1 for channel section details
2) Channels sized for 100 year runoff without overtopping.

Table 6.1 Hydrology/Hydraulics Summary

Channel	Drain	Plate Nos.	Area (sq mi)	Length (ft)	Slope (f/f)	Base Width (ft)	Channel Depth (ft)	ROW (ft)	2 YEAR Q (cfs)	2 YEAR D (ft)	2 YEAR V (f/s)	10 YEAR Q (cfs)	10 YEAR D (ft)	10 YEAR V (f/s)	100 YEAR Q (cfs)	100 YEAR D (ft)	100 YEAR V (f/s)
Line Aj	40 - Aj2	25,26	1.0	19,600	.0127	20	4.2	80	15	.3	2.7	134	1.0	5.6	422	2.2	8.5
Line Ak	50 - Ak2	27	1.5	7,200	.0089	20	5.5	90	11	.3	2.2	167	1.3	5.4	697	3.5	8.8
Line Am	60 - Am2	28	1.5	7,900	.0085	20	5.2	90	14	.3	2.2	187	1.5	5.7	601	3.2	8.3
Line An	70 -8474	29	3.7	8,500	.0082	60	6.3	135	402	1.3	5.3	1,283	2.5	7.9	2,853	4.3	10.7
	8474- An2	29,30	2.2	8,500	.0144	60	4.7	125	236	.8	5.1	840	1.6	8.0	1,833	2.7	10.9
Line Ao	80 - Ao2	31	4.8	6,400	.0141	70	5.0	135	502	1.1	6.2	1,537	3.0	11.5	3,234	3.0	11.5
	Ao2 -7200	31	4.8	800	.0138	40	5.7	115	502	1.1	10.2	1,537	3.0	18.3	3,234	3.0	18.3
	7200- Ao3	31	3.1	3,600	.0167	30	6.1	110	371	1.0	10.6	1,040	1.9	15.4	2,133	3.0	19.7
Line Ap	Ap1 - Ap2	32	.4	3,500	.0114	10	5.3	80	69	1.0	5.3	189	2.0	7.2	379	3.3	8.7
BASIN B																	
Line Ba	- 200	-	12.5	-	-	-		-	1,591	-	-	4,447	-	-	9,024	-	-
	200 - 210	-	10.3	-	-	-		-	1,355	-	-	3,683	-	-	7,429	-	-
	210 - 220	-	6.5	-	-	-		-	902	-	-	2,342	-	-	4,684	-	-
Line Bb	200 - Bb2	-	1.2	2,800	.0529	20	2.0	70	207	1.7	8.1	590	-	-	1,113	-	-
	Bb2 - Bb3	-	.8	1,600	.0169	42"		-	127	3.0	14.3	332	-	-	658	-	-
	Bb3 -5000	-	.5	600	.0167	10	2.0	60	100	1.2	5.1	247	-	-	482	-	-
	5000-5600	-	.5	600	.0233	42"		-	100	2.1	13.3	247	-	-	482	-	-
	5600- Bb4	-	.5	1,400	.0229	10	2.0	60	100	1.1	6.2	247	-	-	482	-	-
	Bb4 - Bb5	-	.5	950	.0221	10	2.0	60	87	1.0	4.0	215	-	-	415	-	-
Line Bc	Bb2 - Bc2	40	.1	-	-	-		-	25	-	-	58	-	-	106	-	-
Line Bd	210 - Bd2	40	.4	-	-	-		-	67	-	-	195	-	-	425	-	-
Line Be	210 - Be2	40	2.1	-	-	-		-	355	-	-	923	-	-	1,736	-	-
Line Bf	220 - Bf2	40	5.1	-	-	-		-	783	-	-	1,954	-	-	3,782	-	-

NOTES: 1) See Figure 6.1 for channel section details.
2) Channels sized for 100 year runoff without overtopping.
3) Channel Bb sized for 2 year storm.

Table 6.1 Hydrology/Hydraulics Summary

Channel	Drain	Plate Nos.	Area (sq mi)	Length (ft)	Slope (f/f)	Base Width (ft)	Channel Depth (ft)	ROW (ft)	2 YEAR Q (cfs)	2 YEAR D (ft)	2 YEAR V (f/s)	10 YEAR Q (cfs)	10 YEAR D (ft)	10 YEAR V (f/s)	100 YEAR Q (cfs)	100 YEAR D (ft)	100 YEAR V (f/s)
BASIN C																	
Railway Channel	50 - 100	7	31.0	6,200	.0095	130	8.1	215	743	1.1	5.1	4,227	3.2	10.1	12,068	6.1	14.9
	100 - 110	7,8	16.7	7,000	.0051	100	8.4	190	743	1.5	4.6	3,157	3.7	8.1	7,316	6.4	11.1
	110 - 120	8,9	7.8	4,600	.0074	50	8.2	135	358	1.3	5.0	1,614	3.4	8.8	3,980	6.2	12.0
	120 - 130	9,10	5.0	7,200	.0071	40	7.6	125	265	1.3	4.9	1,112	3.1	8.0	2,675	5.6	10.8
	130 - 140	10	2.4	5,000	.0058	20	8.2	105	122	1.3	4.4	528	3.3	6.9	1,289	6.2	8.9
	140 - 150	10	1.0	3,300	.0022	10	7.2	90	30	1.1	2.4	120	2.7	3.6	300	5.2	4.4
Line Cb	Cc1 - Cb2	33	4.9	8,800	.0101	40	5.9	110	67	.5	3.2	598	1.9	7.3	1,782	3.9	10.8
Line Cc	100 - Cc1	34	9.5	3,200	.0126	60	6.9	140	240	.8	4.8	1,563	2.5	9.7	4,305	4.9	14.2
	Cb2 - Cc2	34	3.1	8,000	.0161	40	5.5	110	215	.9	5.9	884	2.1	9.8	1,960	3.5	12.9
Line Cd	110 - Cd2	35,36	6.3	11,200	.0168	60	6.0	135	478	1.1	6.8	1,639	2.4	11.0	3,657	4.0	14.7
	Cd2 - Cd3	36	4.7	3,200	.0025	60	8.4	150	503	2.1	3.9	1,439	4.0	5.7	2,961	6.4	7.3
Line Ce	120 - Ce2	37	1.8	7,200	.0191	40	4.5	105	159	.7	[illegible]	556	1.5	8.7	1,235	2.5	11.7
Line Cf	130 - Cf2	38	2.6	10,400	.0157	40	4.9	105	153	.7	4.9	609	1.7	8.5	1,444	2.9	11.5
Line Cg	140 - Cg2	39	2.4	10,400	.0144	20	6.4	95	122	.9	5.6	528	2.5	9.6	1,289	4.4	12.3

NOTES: 1) See Figure 6.1 for channel section details.
2) Channels sized for 100 year runoff without overtopping.

7. PLANNING COST ESTIMATES

Planning cost estimates have been prepared for the proposed improvements and are presented in Table 7.1. These estimates are based on preliminary designs which have not addressed specific design details. The costs include estimates of excavation, linings, structures, and right-of-way acquisition. No other components are included in the estimates; therefore, significant contingencies are included.

Unit costs used in the estimates are shown on Table 7.1. Basically they include:

Earthworks	$1.25 per cubic yard
Channel Lining	$4.00 per square foot
Structures	$60 per cfs
Right-of-Way	$2,000 - $15,000 per acre
Contingency	25 percent

The structures are based on multiple 6 feet x 10 feet box culverts, 100 feet long and are located at section line crossings.

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Table 7.1 Planning Cost Estimate

Channel	Drain	Plate Nos.	Length (ft)	CHANNEL COST Earthwks (cy)	Rate ($/cy)	Lining @ $4/sf ($)	Total ($)	STRUCTURE COST No.	Total $60/cfs ($)	ROW COST ROW (ac)	Rate ($/ac)	Total ($)	CONTINGENCY @ 25% ($)	TOTAL COST ($)
Mohave	10 - 20	1	6,300	1,000,603	1.25		1,250,754	-		114	2,000	227,066	369,455	1,847,275
Channel	20 - 30	1,2	6,300	816,060	1.25		1,020,075	1	715,380	99	2,000	198,140	483,399	2,416,994
	30 - 40	2	5,900	493,153	1.25		616,441	1	457,440	66	2,000	131,382	301,316	1,506,578
	40 - 50	2,3	5,600	484,794	1.25		605,993	2	914,880	62	2,000	124,702	411,394	2,056,968
	50 - 60	3	7,700	358,934	1.25		448,668	2	574,080	24	5,000	119,318	285,516	1,427,582
	60 - 70	4	1,500	46,750	1.25		58,438	-		3	5,000	13,774	18,053	90,265
	70 - 80	4	9,200	230,511	1.25		288,139	3	532,260	11	5,000	52,801	218,300	1,091,500
	80 - 90	5	7,900	69,783	1.25		87,229	-					21,807	109,036
			50,400	3,500,589			4,375,736	9	3,194,040	378		867,183	2,109,240	10,546,199
Line Ad	Ad1 - Ad2	11,12	18,400	364,933	1.25		456,167	3	550,980	93	5,000	464,646	367,948	1,839,741
	Ad2 - Ad3	12,13	5,200	114,920	1.25		143,650	-		26	5,000	131,313	68,741	343,704
	Ad3 - Ad4	13-15	16,000	244,800	1.25		306,000	2	346,440	79	5,000	394,858	261,824	1,309,122
	Ad4 - Ad5	15	2,000	20,904	1.25		26,130	-		7	5,000	34,435	15,141	75,706
	Ad5 - Ad6	15	2,000	4,600	1.25		5,750	-		4	5,000	20,661	6,603	33,014
			43,600	750,157			937,696	5	897,420	209		1,045,914	720,257	3,601,287
Line Ae	20 - Ae2	16	6,400	192,474	1.25		240,593	1	151,314	40	5,000	202,020	148,482	742,408
Line Af	30 - Af2	17	6,800	293,105	1.25		366,381	1	332,820	51	5,000	253,673	238,219	1,191,093
	Af2 - Af3	17,18	10,800	414,920	1.25		518,650	2	665,683	81	5,000	402,893	396,808	1,984,038
	Af3 - Af6	18	4,800	12,267	1.25		15,333	1	13,560	9	5,000	46,832	18,931	94,657
			22,400	720,292			900,365	4	1,012,063	141		703,398	653,958	3,269,788
Line Ag	30 - Ag2	19,20	20,000	282,296	1.25		352,870	4	528,084	78	8,000	624,426	376,345	1,881,726
	Ag2 - Ag3	21,22	11,000	125,889	1.25		157,361	2	243,456	43	8,000	343,434	186,063	930,314
	Ag3 - Ag4	22	3,900	41,961	1.25		52,451	1	62,355	13	8,000	107,438	55,561	277,806
			34,900	450,146			562,683	7	833,895	134		1,075,298	617,969	3,089,845

NOTES: 1) ROW for Mohave Channel assumes 150' ROW exists between Nodes 50 -90.

Table 7.1 Planning Cost Estimate

Channel	Drain	Plate Nos.	Length (ft)	CHANNEL COST Earthwks (cy)	Rate ($/cy)	Lining @ $4/sf ($)	Total ($)	STRUCTURE COST No.	Total $60/cfs ($)	ROW COST ROW (ac)	Rate ($/ac)	Total ($)	CONTIN-GENCY @ 25% ($)	TOTAL COST ($)
Line Ah	30 - Ah2	23	7,200	39,573	1.25		49,467	2	60,102	19	8,000	152,066	65,409	327,043
Line Ai	40 - Ai2	24	7,400	23,324	1.25		29,155	-		15	8,000	122,314	37,867	189,336
Line Aj	40 - Aj2	25,26	19,600	36,732	1.25		45,915	3	24,120	36	8,000	287,971	89,501	447,507
Line Ak	50 - Ak2	27	7,200	21,467	1.25		26,833	2	20,040	15	10,000	148,760	48,908	244,542
Line Am	60 - Am2	28	7,900	21,535	1.25		26,919	2	22,440	16	10,000	163,223	53,145	265,727
Line An	70 -8474	29	8,500	-	1.25			1	76,980	-	10,000		19,245	96,225
	8474- An2	29,30	8,500	-	1.25			1	50,400	-	10,000			50,400
			17,000					2	127,380				19,245	146,625
Line Ao	80 - Ao2	31	6,400	51,911	1.25		64,889	1	92,244	20	10,000	198,347	88,870	444,350
	Ao2 -7200	31	800	3,822	1.25	192,000	196,778	-		2	10,000	21,120	54,475	272,373
	7200- Ao3	31	3,600	13,200	1.25	720,000	736,500	-		9	10,000	90,909	206,852	1,034,261
			10,800	68,933		912,000	998,167	1	92,244	31		310,376	350,197	1,750,984
Line Ap	Ap1 - Ap2	32	3,500	5,561	1.25		6,951	1	11,340	6	15,000	96,419	28,678	143,388
Line Bb	200 - Bb2	40	2,800	84,135	1.25		105,169	-		4	10,000	44,995	37,541	187,705
	Bb2 - Bb3	40	1,600	3,700	5.00	160,000	178,500	-		-				178,500
	Bb3 -5000	40	600	18,029	1.25		22,536	-		1	10,000	8,264	7,700	38,501
	5000-5600	40	600	1,380	5.00	60,000	66,900	-		-				66,900
	5600- Bb4	40	1,400	42,067	1.25		52,584	-		2	10,000	19,284	17,967	89,835
	Bb4 - Bb5	40	950	28,546	1.25		35,682	-		1	10,000	13,085	12,192	60,959
			7,950	177,857		220,000	461,371			9		85,629	75,400	622,400

NOTES: 1) Line Bb sections Bb2-Bb3 and sta 5000-5600 are 42" dia RCP.

Table 7.1 Planning Cost Estimate

Channel	Drain	Plate Nos.	Length (ft)	CHANNEL COST Earthwks (cy)	CHANNEL COST Rate ($/cy)	CHANNEL COST Lining @ $4/sf ($)	CHANNEL COST Total ($)	STRUCTURE COST No.	STRUCTURE COST Total $60/cfs ($)	ROW COST ROW (ac)	ROW COST Rate ($/ac)	ROW COST Total ($)	CONTINGENCY @ 25% ($)	TOTAL COST ($)
Railway	50 - 100	7	6,200	186,299	1.25		232,873	1	253,611	31	10,000	306,015	198,125	990,624
Channel	100 - 110	7,8	7,000	170,904	1.25		213,630			31	10,000	305,326	129,739	648,695
	110 - 120	8,9	4,600	55,984	1.25		69,980			14	10,000	142,562	53,135	265,677
	120 - 130	9,10	7,200	64,213	1.25		80,267			21	10,000	206,612	71,720	358,598
	130 - 140	10	5,000	26,407	1.25		33,009			12	10,000	120,523	38,383	191,916
	140 - 150	10	3,300	8,262	1.25		10,328			7	10,000	68,182	19,627	98,137
			33,300	512,069			640,086	1	253,611	115		1,149,219	510,729	2,553,646
Line Cb	Cc1 - Cb2	33	8,800	54,658	1.25		68,322	2	71,760	22	8,000	177,778	79,465	397,325
Line Cc	100 - Cc1	34	3,200	36,587	1.25		45,733	1	93,801	10	8,000	82,277	55,453	277,265
	Cb2 - Cc2	34	8,000	44,593	1.25		55,741			20	8,000	161,616	54,339	271,696
			11,200	81,179			101,474	1	93,801	30		243,893	109,792	548,961
Line Cd	110 - Cd2	35,36	11,200	104,533	1.25		130,667	1	98,345	35	8,000	277,686	126,675	633,373
	Cd2 - Cd3	36	3,200	47,787	1.25		59,733	1	86,335	11	8,000	88,154	58,555	292,777
			14,400	152,320			190,400	2	184,680	46		365,840	185,230	926,150
Line Ce	120 - Ce2	37	7,200	28,667	1.25		35,833	1	33,360	17	8,000	138,843	52,009	260,045
Line Cf	130 - Cf2	38	10,400	48,033	1.25		60,041	2	73,050	25	8,000	200,551	83,410	417,052
Line Cg	140 - Cg2	39	10,400	38,981	1.25		48,726	2	63,360	23	8,000	181,451	73,384	366,921
	TOTAL		341,950	6,924,545		1,292,000	9,966,732	50	7,220,025	1,328		7,718,147	6,152,276	31,057,180

8. IMPLEMENTATION

The implementation of the proposed improvements must be properly planned and executed to avoid exposing the public to increased hazard. Since the likelihood of simultaneous construction of all facilities is small, a phased approach should be adopted. A phasing plan must address many issues including drainage problems and funding.

The first step in implementing a plan for the construction of improvements is the adoption of this Master Drainage Plan. This establishes the location of proposed drainage corridors and channel sections. The Drainage Design and Administrative Manual should also be adopted and enforced. This establishes procedures for the integration of development into the overall drainage system and provides the City and County with a drainage infrastructure outside of the major drainageways.

In general, drainage improvements must be constructed in a manner which does not expose any property to increased hazard. To satisfy this requirement, the phasing plan must be carefully conceived. Under ideal conditions, this objective can be achieved by beginning the construction of improvements at the downstream limits of the drainageways. This provides the necessary protection to downstream properties without impacting upstream properties. This approach, while satisfying the requirements of not exposing property to increased hazard, does not necessarily provide relief to those properties presently being exposed to flood hazard. A more reasonable approach is to provide improvements in areas where development is taking place and to carefully evaluate the impacts of those improvements on downstream properties.

The acquisition of right-of-way should begin as quickly as possible as this establishes a permanent public corridor for future drainage improvements; thereby removing the property from development pressures. Prior to right-of-way acquisition a detailed boundary survey of the channels should be conducted and since right-of-way acquisition will not be possible all at once, the City and County should develop a method of prohibiting construction within the proposed right-of-way.

The simultaneous construction of drainage improvements within the study area is impractical and unlikely. However, improvements are needed and should proceed in the following general manner:

1. Adopt Administrative and Design Manual.

2. Identify actual alignment, and conduct field surveys.

3. Prepare legal descriptions and map properties to be affected.

4. Develop and implement a method of prohibiting construction within proposed rights-of-way.

5. Acquire right-of-way as it becomes available.

6. Coordinate new development with the drainage study.

7. Construct the railroad diversion channel proposed along the southeast edge of the AT&SF Railroad right-of-way. Extend the improvements to the Mohave Channel.

8. Improve the Mohave Channel within the area of existing development. This should generally be accomplished from the downstream end proceeding upstream.

9. Construct improvements in other areas of existing development after carefully evaluating the impacts of those improvements on downstream properties.

10. Encourage the construction of improvements within and adjacent to new developments.

11. Evaluate the use of exactions from new developments to share in the cost of drainage improvements.

AMENDMENT NO. 1
to the
KINGMAN AREA MASTER DRAINAGE PLAN

1. INTRODUCTION

Since the completion of the Kingman Area Master Drainage Plan in 1988, several local studies and development plans have indicated a need to consider changes to the plan. This amendment covers changes in the drainage concept specifically related to one "major drainageway" (Line Cg) in the south central portion of the City of Kingman. With these plan changes, the drainage patterns in this area will then more nearly match existing conditions and implementation costs will be significantly less.

1. DESCRIPTION

The Master Drainage Plan calls for construction of a Line Cg that would begin just north of Hualapai Mountain Road, approximately 1,700 feet southeast of the intersection of Eastern Street and Hualapai Mountain Road and would run north and west to near the intersection of Ross Avenue and Railroad Street. This channel would intercept and convey flows from the southeast to the proposed Railway Channel. Almost two square miles of area would drain into Line Cg. The plan indicates Line Cg is to be an unlined channel constructed in a 95-foot wide right-of-way. It would be designed for estimated 10-year flows of 528 cubic feet per second (cfs) and 100-year flows of 1,289 cfs.

3. PROPOSED CHANGES

Presently, there is a diversion dike/channel located along the north line of the southwest quarter of Section 20. This dike intercepts drainage flow parallel to Hualapai Mountain Road and diverts it through a dip section across Hualapai Mountain Road and into Slaughterhouse Canyon. This diversion apparently occurred a number of years ago to reduce potential flooding of the Cecil Davis Subdivisions. This condition is not acknowledged in the Master Drainage Plan as it calls for all drainage along the north side of Hualapai Mountain Road to flow north in Line Cg. If the current drainage patterns are maintained. however, flows to proposed Line Cg will be reduced from those projected in the Master Drainage Plan. This will allow a reduction in the size of Line Cg (and other drainage facilities to the north). To further reduce flows to Line Cg, it is recommended the diversion be extended approximately 1,000 feet east to intercept flow from one additional small drainage area. The flow to Slaughter House Canyon has posed few problems in the past.

Registered Professional Engineer (Civil)
CERTIFICATE NO.
21289
PETER K.
JOHNSON
Date Signed 4-16-91
ARIZONA U.S.A.

Construction of the channel section for Line Cg in a 95-foot right-of-way as described in the Master Drainage Plan would require acquisition of at least 165 twenty-five foot wide lots in the Golden Gate Subdivision. Several of these lots are already developed and it is expected up to 40 additional lots may be developed soon. A rough estimate of the current cost to acquire these lots exceeds $400,000.00. If drainage flow can be carried in the streets, only about 10 lots in the Golden Gate Subdivision will have to be acquired. Estimated flows are shown in Table I and typical sections are attached.

Table I

Line	Segment	Est. Q10	Q, cfs Q100	Design Q
Cg	A - B	36	70	75
Cg	B - C	64	130	130
Southern Ave	B to Eastern	75	140	140
Southern Ave	Eastern to Adams	130	280	300
Southern Ave	Adams to Railroad	111	250	300
Adams Street	Southern to Railroad	111	250	300
Diversion	at Center Section 20	98	243	250
Diversion	at HMR	283	677	700
Diversion	1000 SW of HMR			1000

If a portion of the drainage flow continues to be diverted across Hualapai Mountain Road, remaining flows through the Golden Gate Subdivision will be low enough to be carried in improved streets. The streets carrying major flows would be Southern Avenue from about 2,000 feet east of Eastern to Railroad Street and Adams Street from Southern to Berry Avenue. Right-of-way will still be needed for that segment of Line Cg through the northwest quarter of Section 20 east of Hualapai Elementary School, but the 95-foot width can be reduced substantially. Right-of-way will also have to be acquired through two blocks north of Berry Avenue as an extension of Adams Street. Detention facilities should be considered in this area.

4. IMPLEMENTATION

It is recommended steps be taken to implement this amendment as follows:

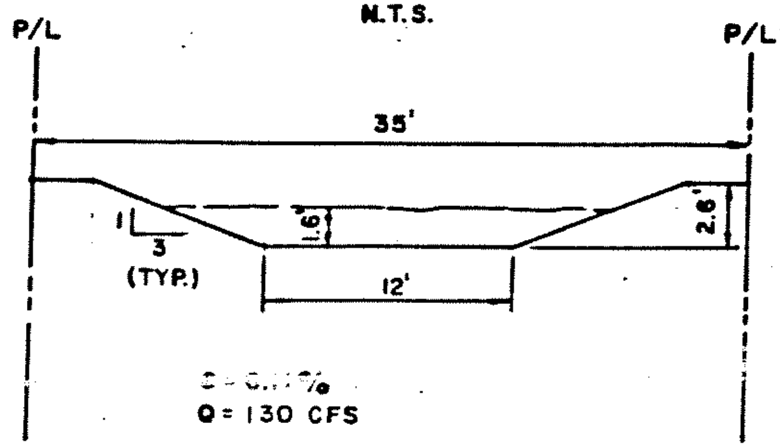
1. Future development in the Golden Gate Addition should conform to this revised drainage scheme. Street improvements between Eastern and Adams Street should be designed in accordance with this amendment to drain to Adams. As the east/west streets are developed, portions of Adams Street will have to be graded to carry flow to the north. It is recommended the City acquire several lots in Blocks 52 and 54, beyond the north end of Adams Street to receive additional flows. Consideration should be given to providing detention in this area as development occurs.

2. Development in Section 20 should also conform with this amendment. Adequate right-of-way should be obtained for the diversion dike/channel, channel to Slaughter House Canyon and Line Cg. Plans should be developed to construct these facilities. It will probably not be possible to construct Line Cg until Southern Avenue is improved to accept the additional flow, however, the right-of-way should be obtained and could be used for temporary detention facilities.

3. Designs should be prepared for necessary Southern Avenue improvements. A plan should be developed for constructing these improvements.

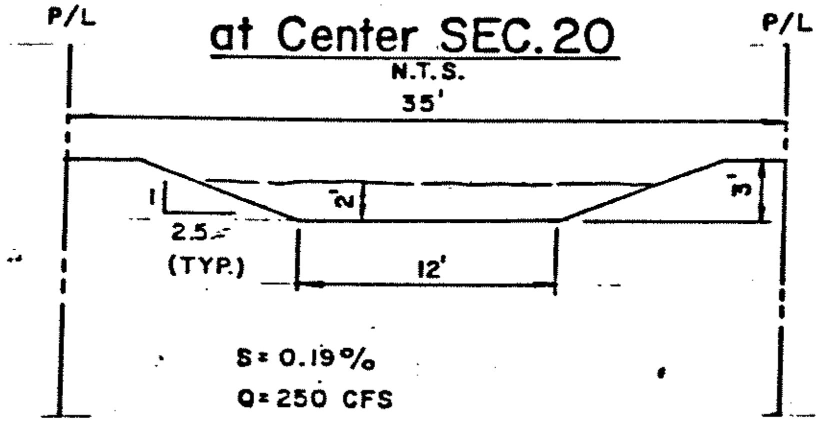
CHANNEL C_g
NW 1/4 SEC. 20

N.T.S.



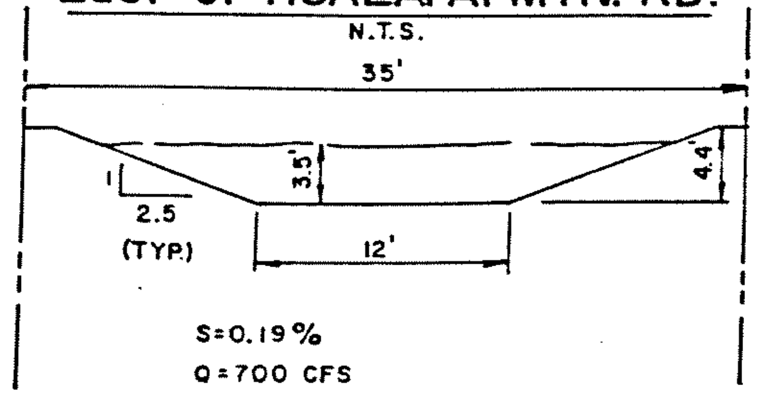
DIVERSION CHANNEL
at Center SEC. 20

N.T.S.



DIVERSION CHANNEL
East of HUALAPAI MTN. RD.

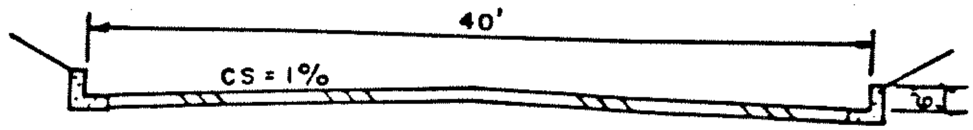
N.T.S.



STREET SECTIONS

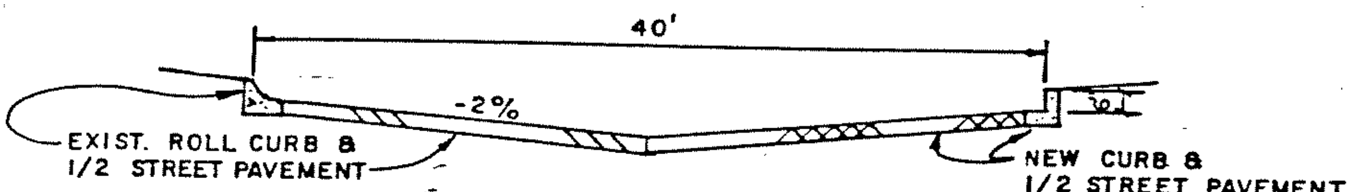
N.T.S.

SOUTHERN EAST OF EASTERN



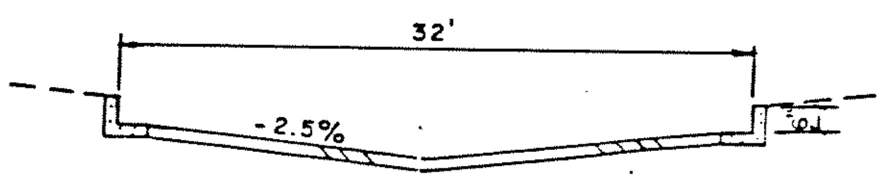
S = 0.13 %
Q TOP OF CURB = 90 CFS
Q 0.2' OVER CURB = 170 CFS

SOUTHERN WEST OF EASTERN

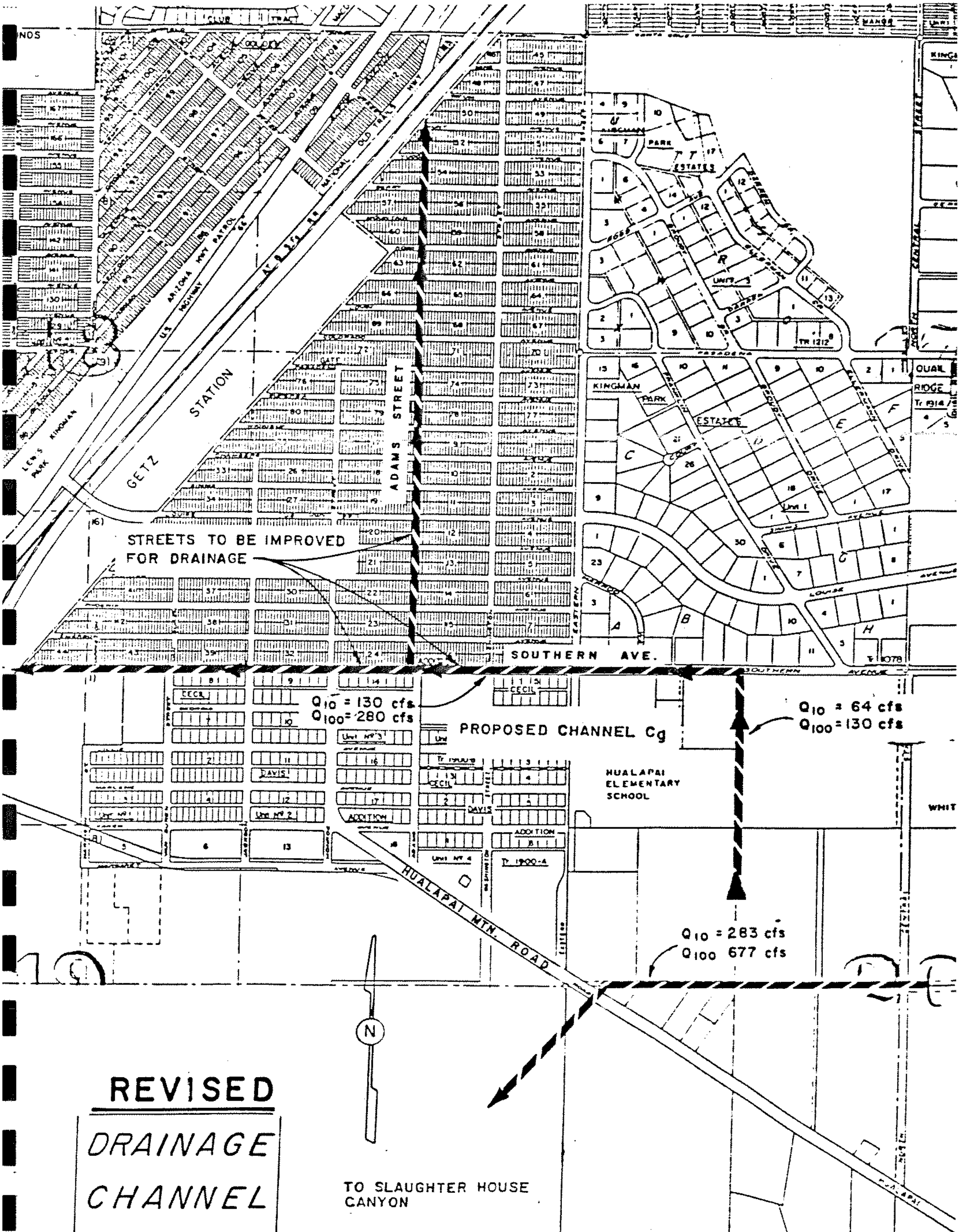


S = 0.15 %
Q TOP OF CURB = 170 CFS
Q 0.3' OVER CURB = 290 CFS

ADAMS STREET

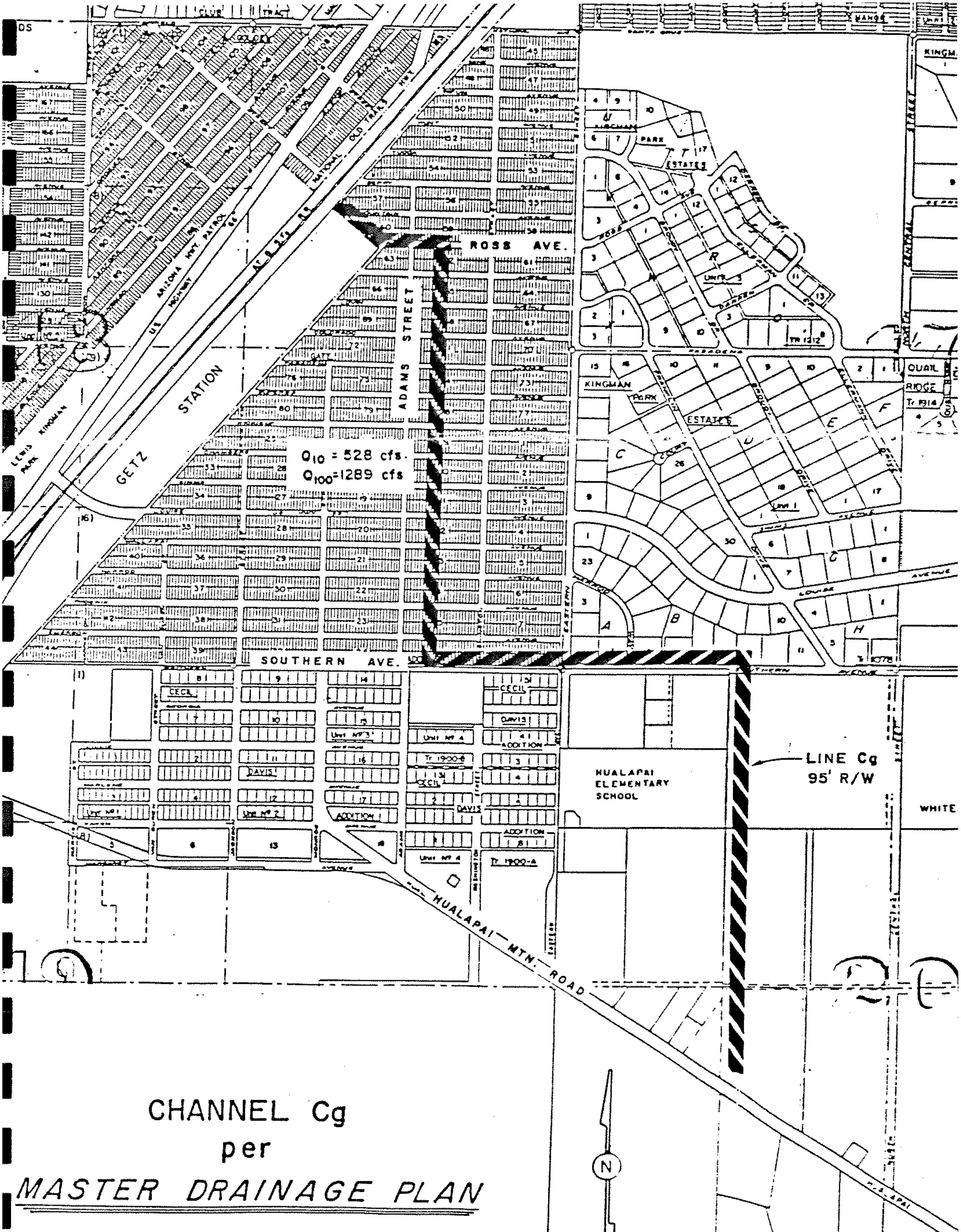


S = 0.12 % (MIN.)
Q TOP OF CURB = 170 CFS
Q 0.3' OVER CURB = 320 CFS

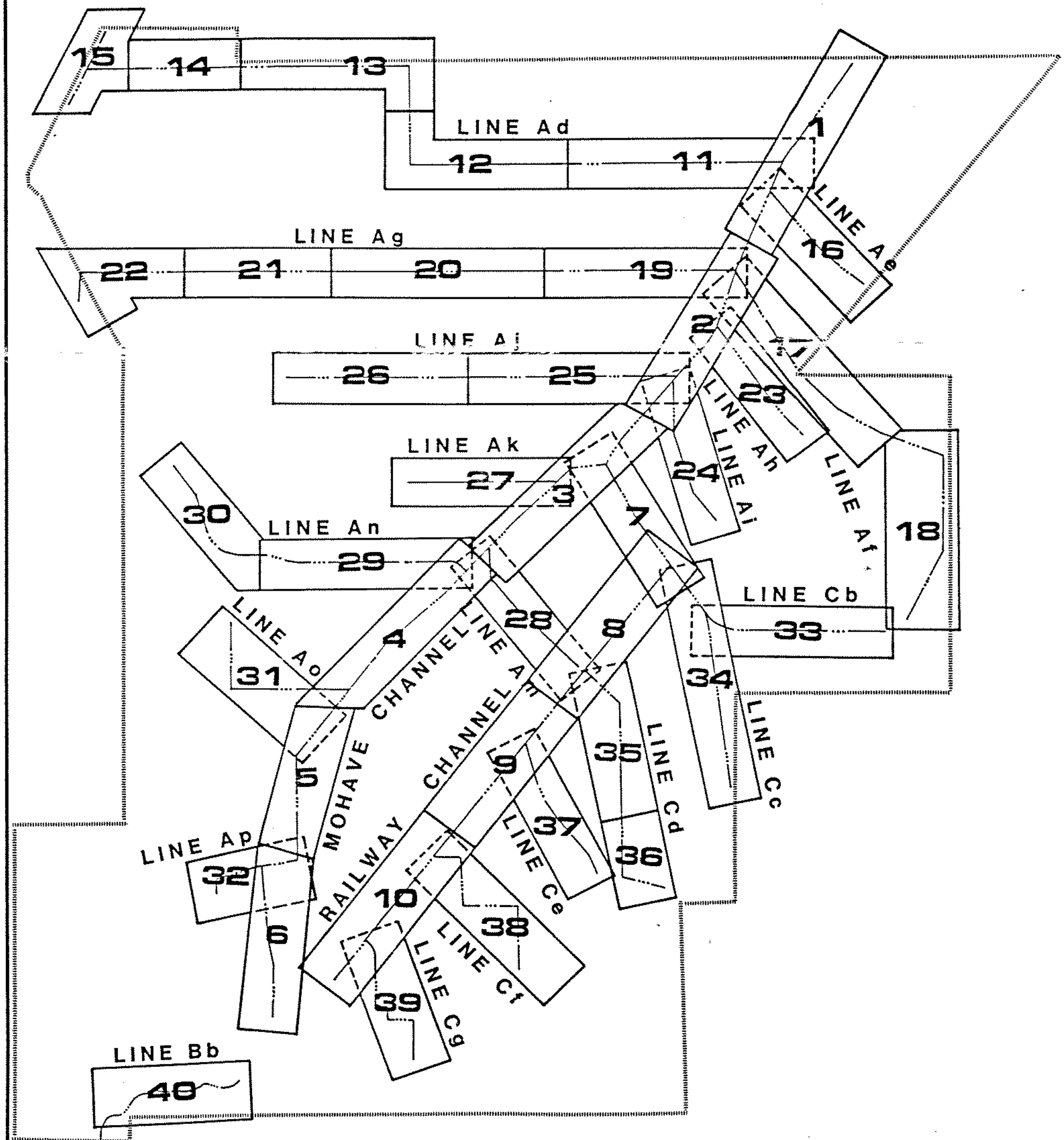


REVISED

DRAINAGE CHANNEL



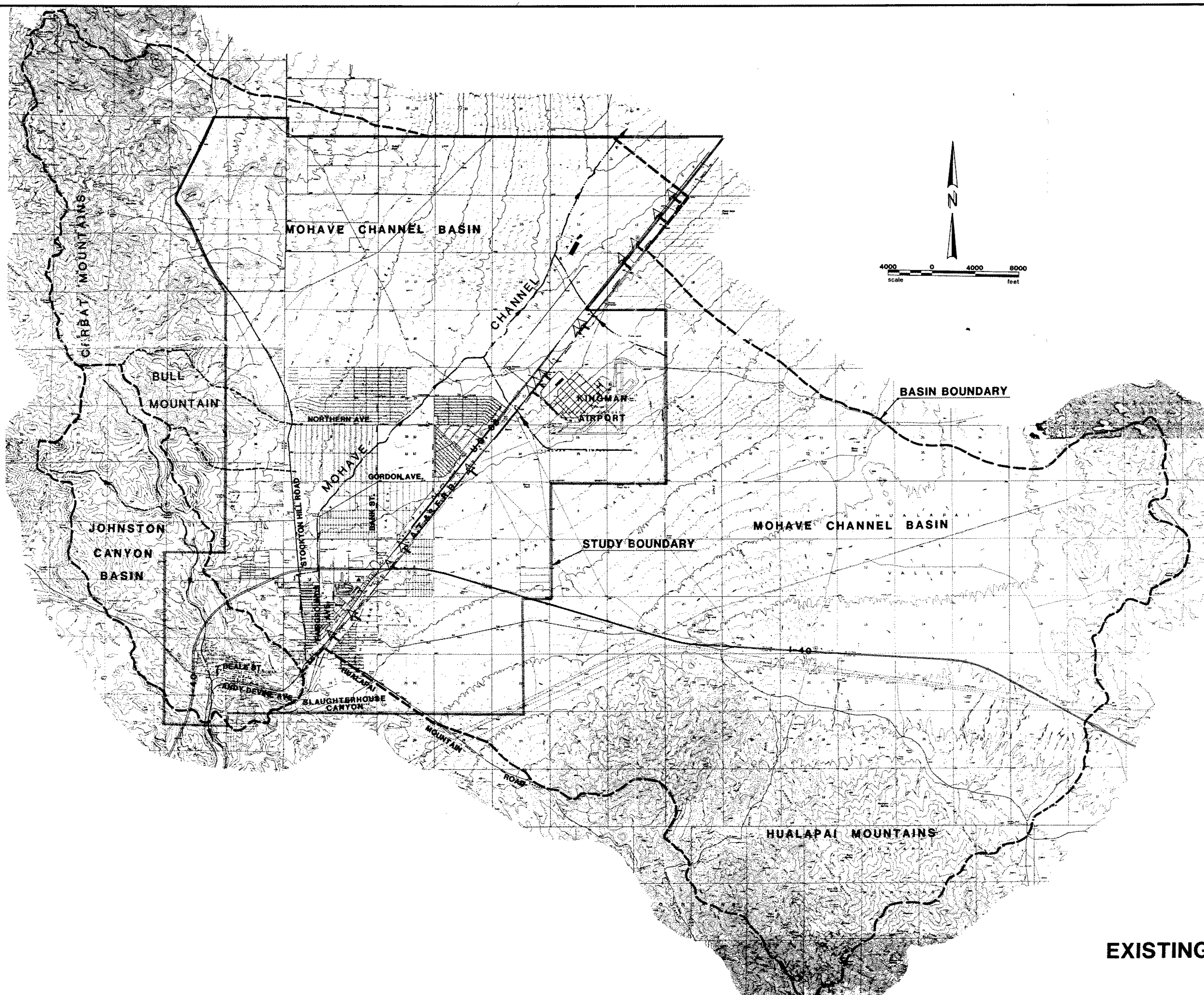
CHANNEL Cg
per
MASTER DRAINAGE PLAN



LINE Ad
LINE Ag
LINE Ae
LINE Aj
LINE Ak
LINE An
LINE Ah
LINE Ai
LINE Af
LINE Ao
LINE Am
LINE Cb
LINE Cc
LINE Cd
LINE Ce
LINE Cf
LINE Cg
LINE Ap
LINE Bb
MOHAVE CHANNEL
RAILWAY CHANNEL
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40

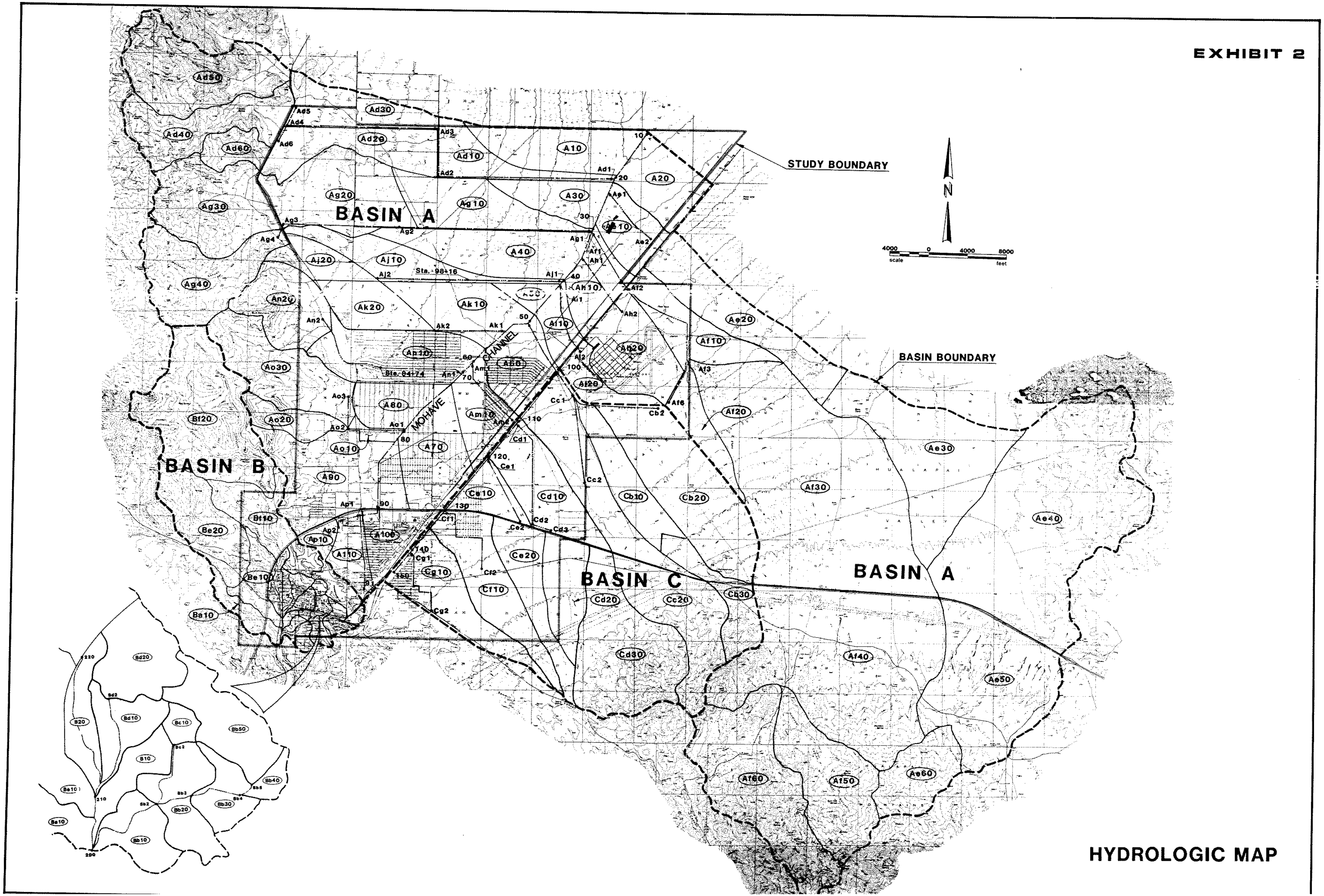
PLATE INDEX

EXHIBIT 1



EXISTING CONDITIONS

EXHIBIT 2



HYDROLOGIC MAP

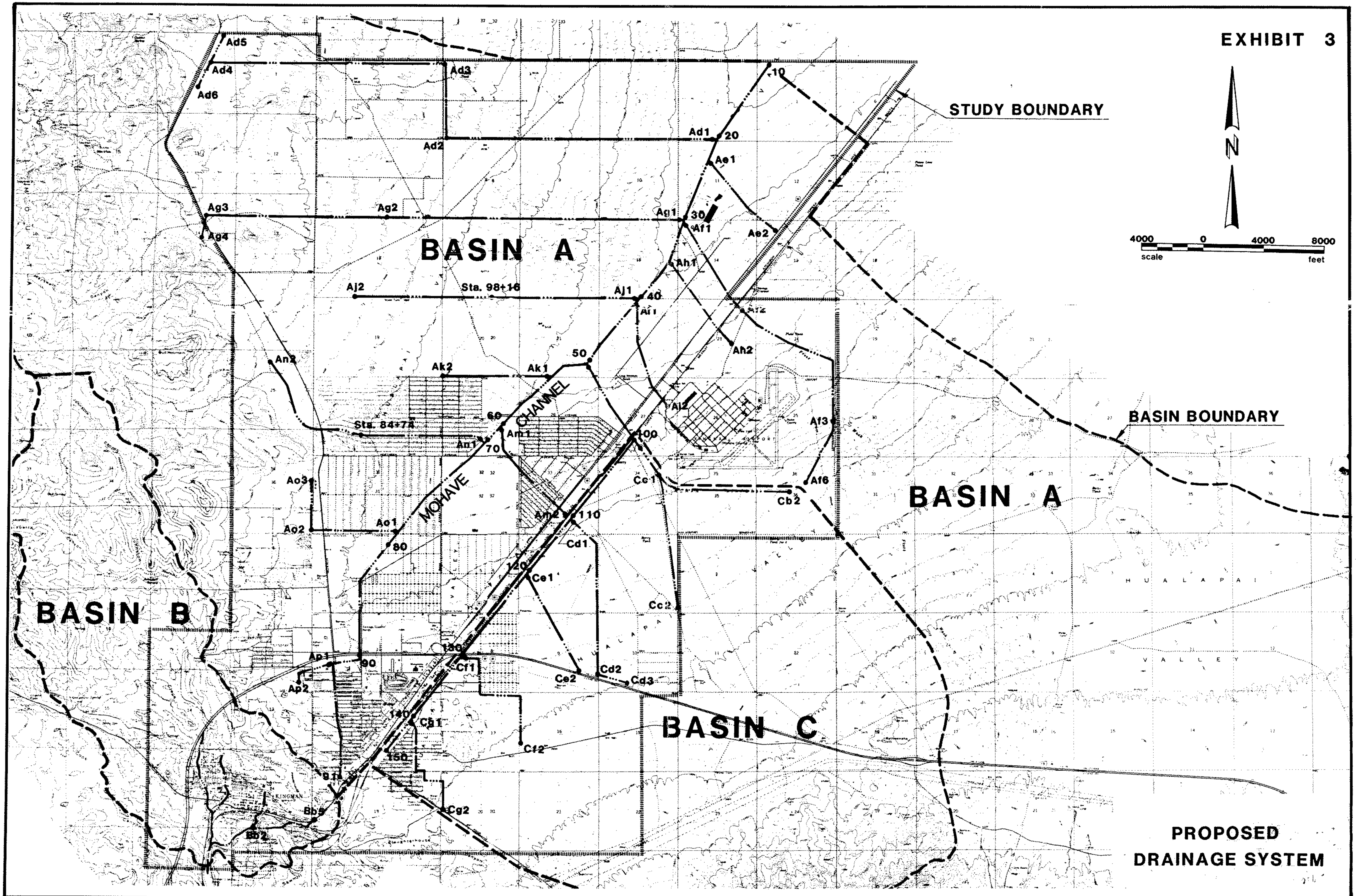
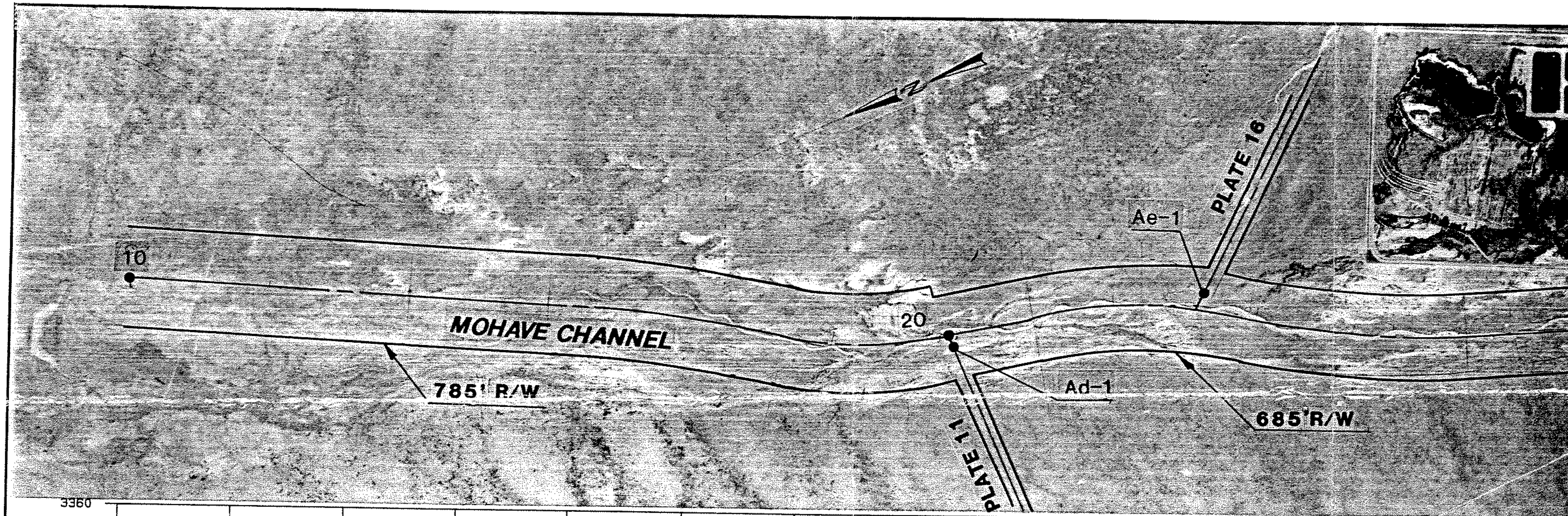
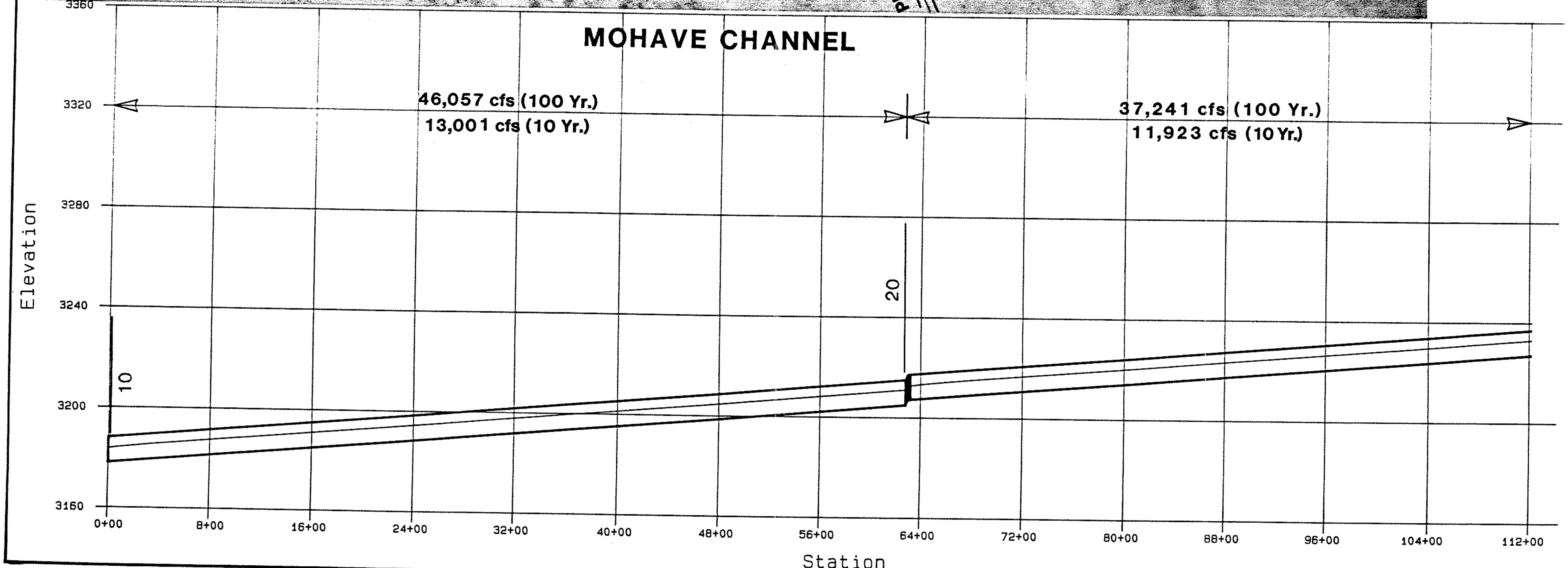


EXHIBIT 3
STUDY BOUNDARY
N
4000 0 4000 8000
scale
feet
BASIN A
BASIN A
BASIN B
BASIN C
BASIN BOUNDARY
MOHAVE CHANNEL
Sta. 98+16
Sta. 84+74
Ad1
Ad2
Ad3
Ad4
Ad5
Ad6
Ae1
Ae2
Af1
Af2
Af3
Af6
Ag1
Ag2
Ag3
Ag4
Ah1
Ah2
Aj1
Aj2
Ak1
Ak2
Am1
Am2
An1
An2
Ao1
Ao2
Ao3
Ap1
Ap2
Bb2
Bb5
Cb1
Cb2
Cc1
Cc2
Cd1
Cd2
Cd3
Ce1
Ce2
Cf1
Cf2
Cg2
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
KINGMAN
H U A L A P A I
V A L L E Y
PROPOSED
DRAINAGE SYSTEM

PLATE 1

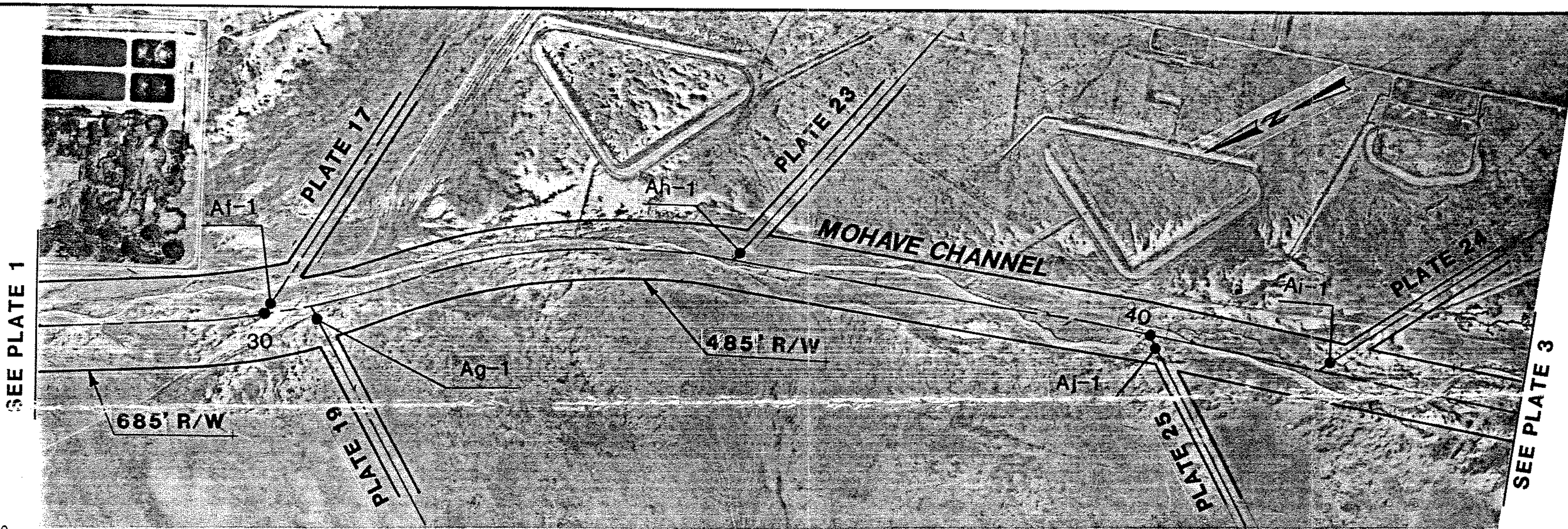


N
PLATE 16
Ae-1
10
20
MOHAVE CHANNEL
785' R/W
Ad-1
685' R/W
PLATE 11
SEE PLATE 2



MOHAVE CHANNEL
46,057 cfs (100 Yr.)
13,001 cfs (10 Yr.)
37,241 cfs (100 Yr.)
11,923 cfs (10 Yr.)
Elevation
3360
3320
3280
3240
3200
3160
10
20
0+00
8+00
16+00
24+00
32+00
40+00
48+00
56+00
64+00
72+00
80+00
88+00
96+00
104+00
112+00
Station

PLATE 2



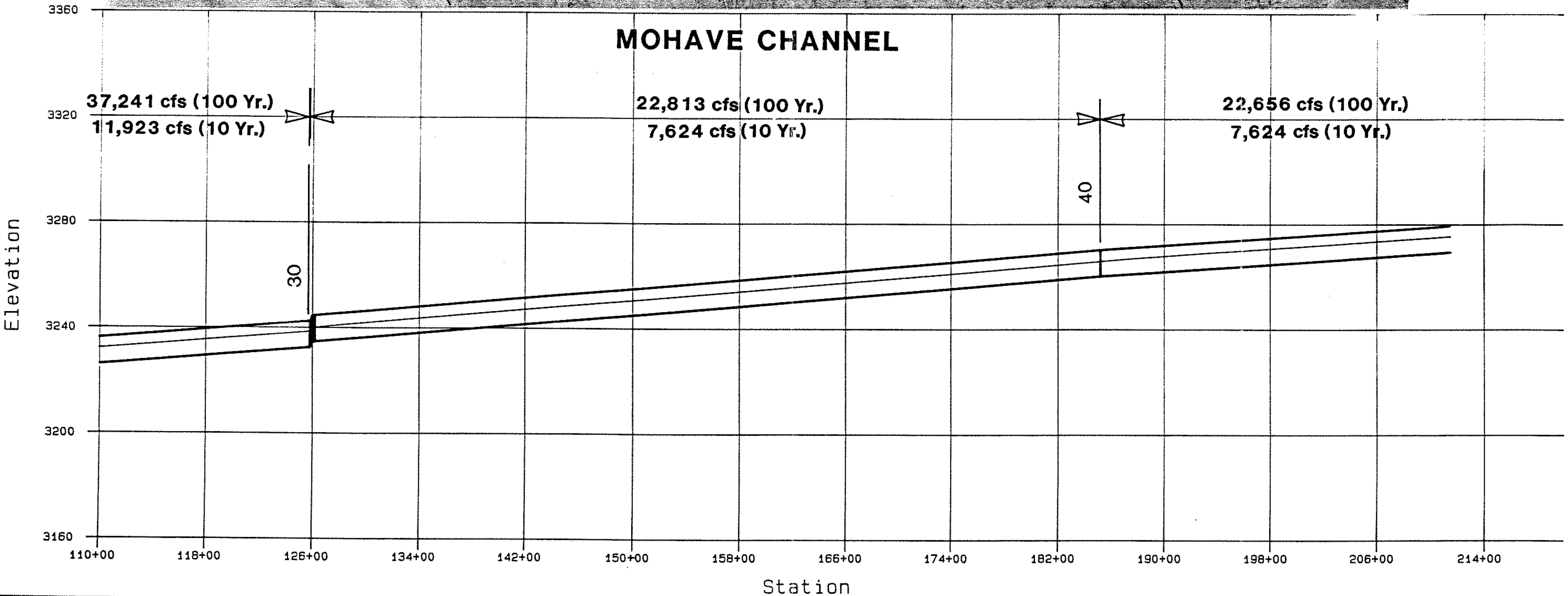


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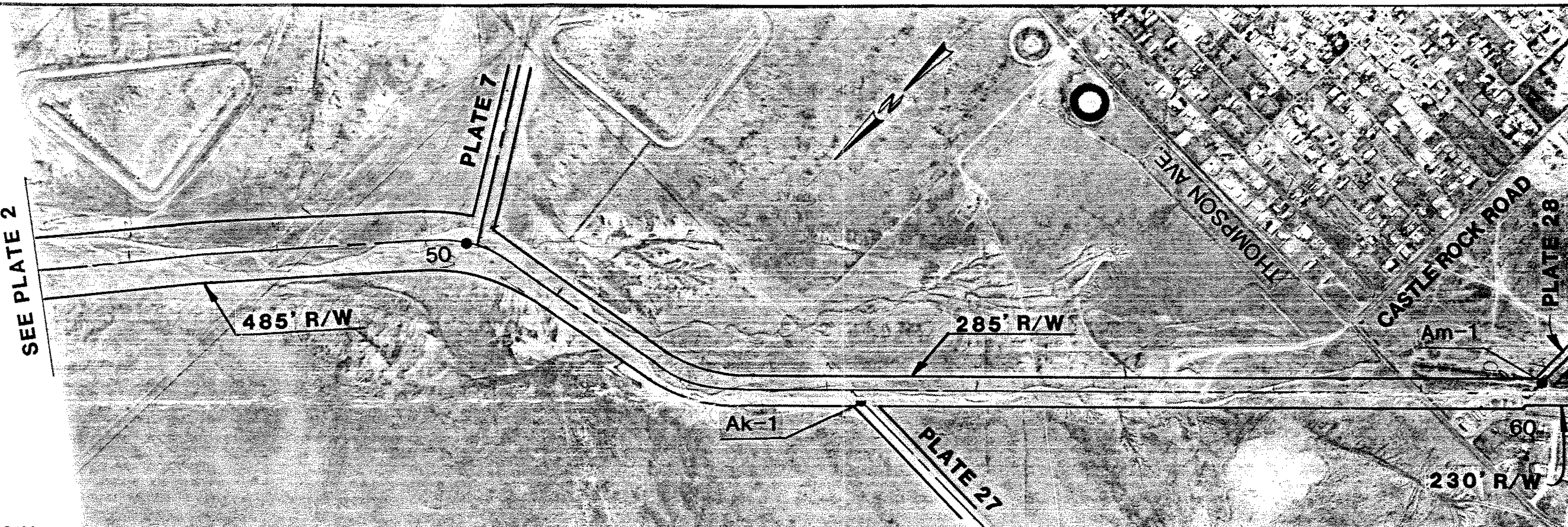
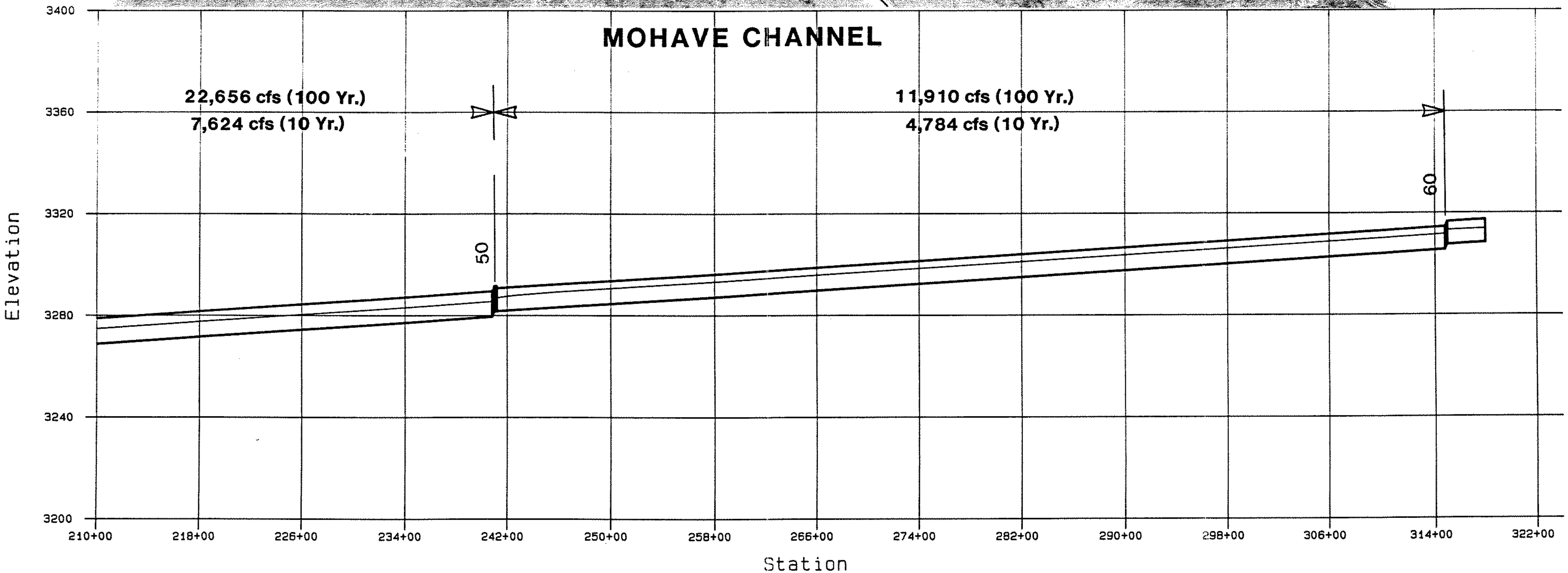
PLATE 3





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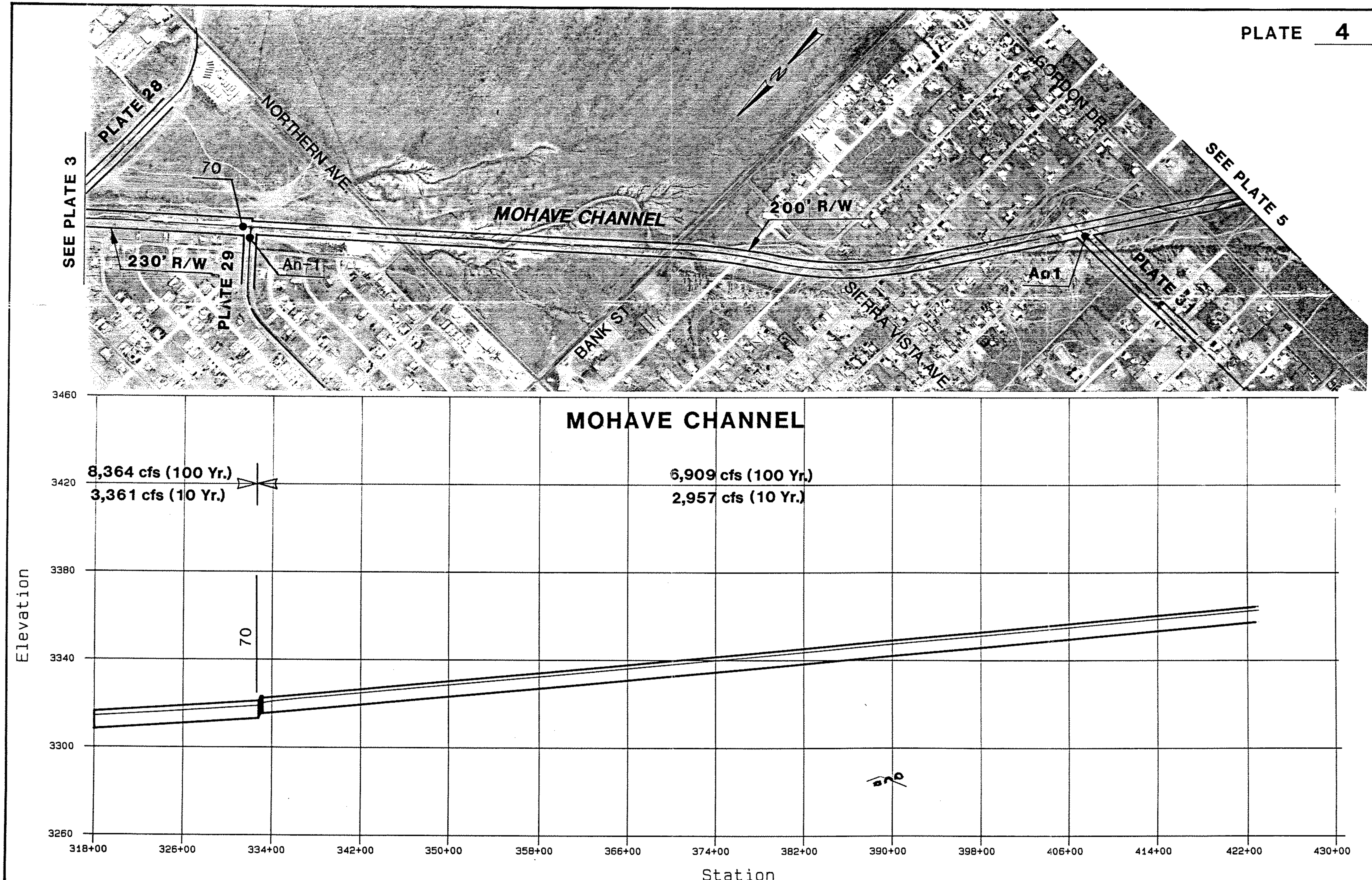
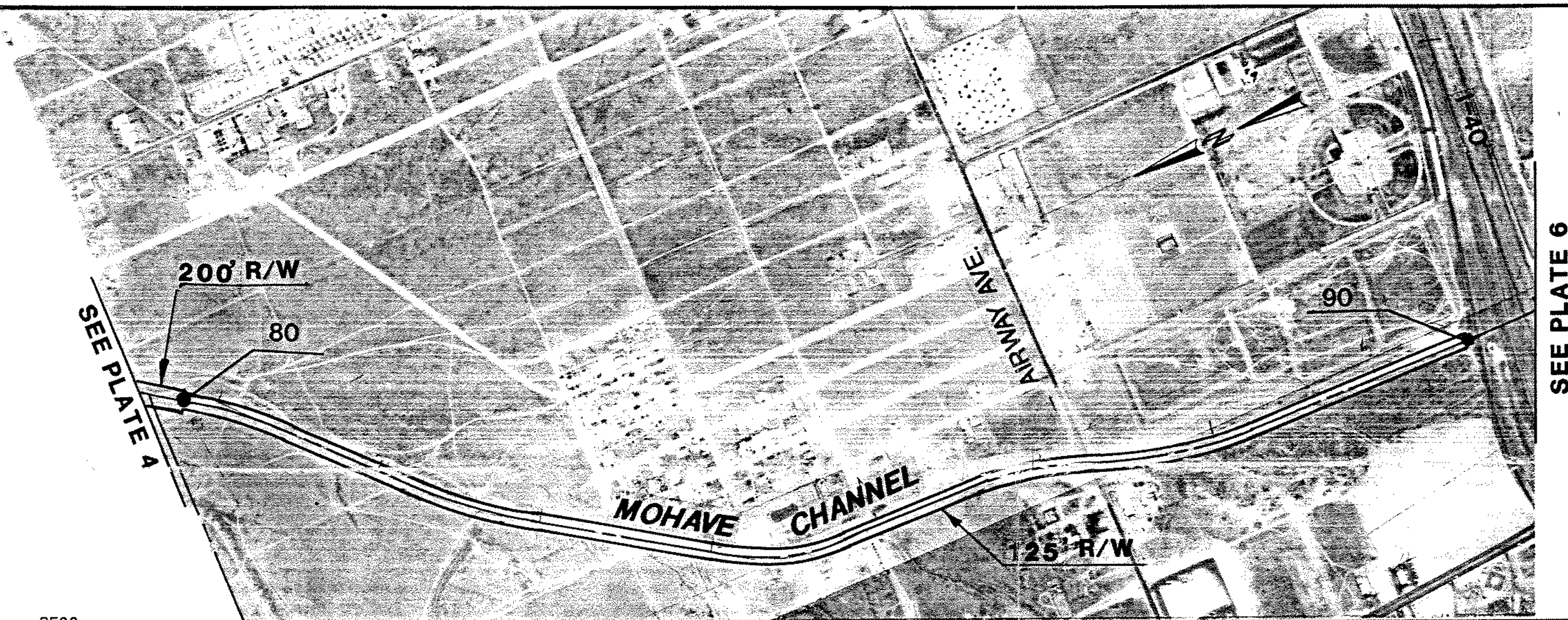
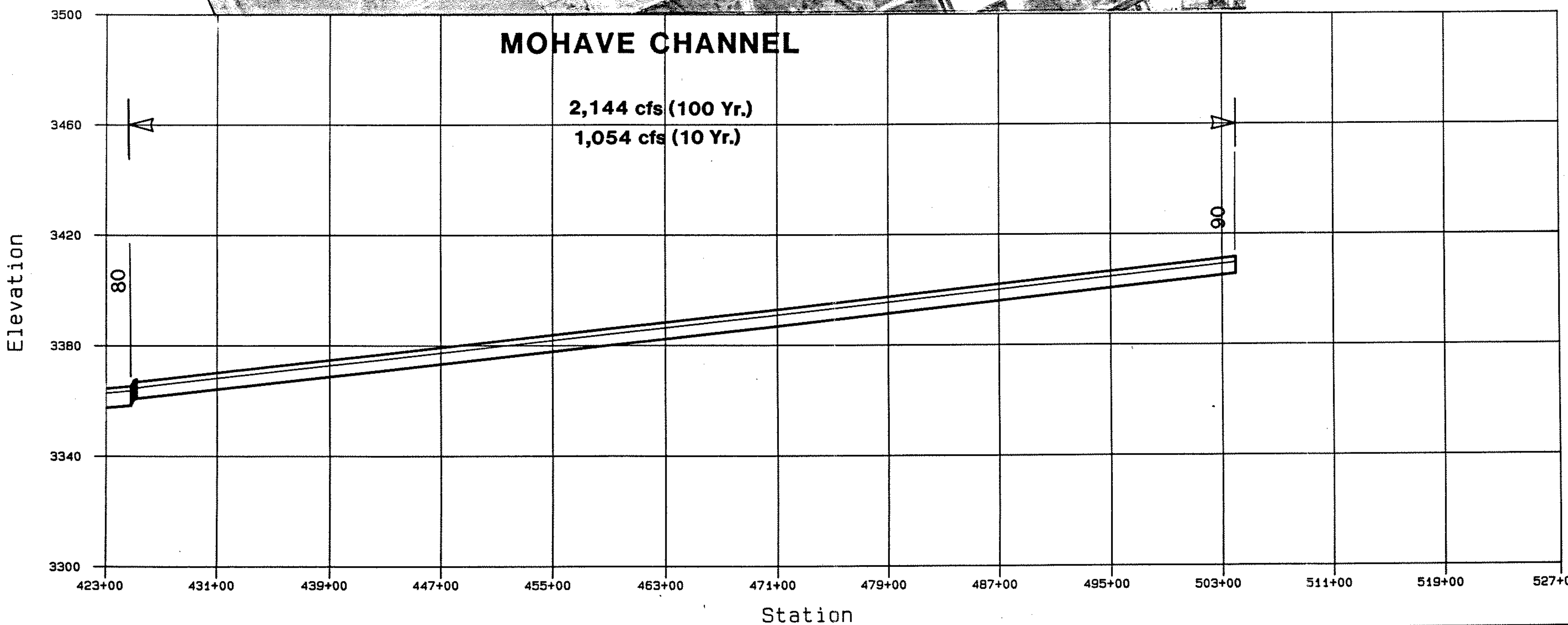
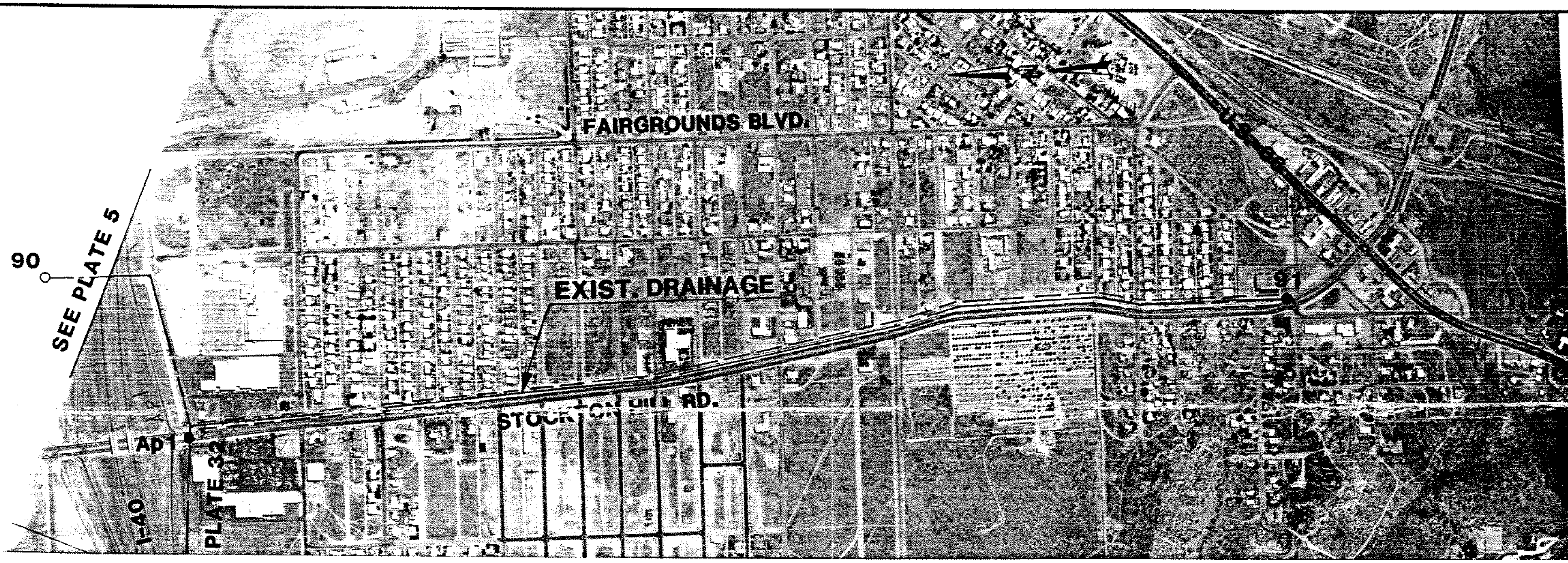


SEE PLATE 3
PLATE 28
NORTHERN AVE
70
MOHAVE CHANNEL
230' R/W
PLATE 29
An-1
BANK ST
200' R/W
SIERRA VISTA AVE
GORDON DR.
SEE PLATE 5
Ao1
PLATE 31
N
MOHAVE CHANNEL
8,364 cfs (100 Yr.)
3,361 cfs (10 Yr.)
6,909 cfs (100 Yr.)
2,957 cfs (10 Yr.)
70
Elevation
3460
3420
3380
3340
3300
3260
318+00
326+00
334+00
342+00
350+00
358+00
366+00
374+00
382+00
390+00
398+00
406+00
414+00
422+00
430+00
Station

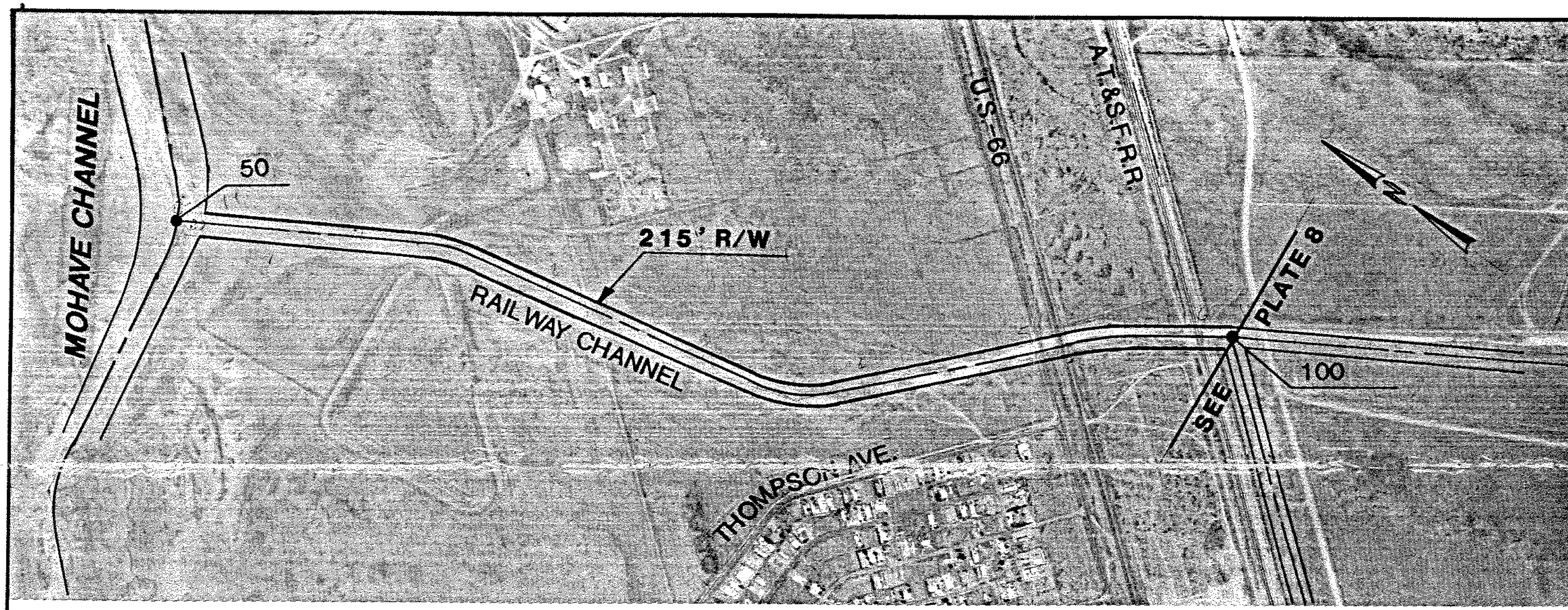
PLATE 5


200' R/W
80
SEE PLATE 4
MOHAVE CHANNEL
125' R/W
AIRWAY AVE.
90'
N
I-40
SEE PLATE 6


MOHAVE CHANNEL
2,144 cfs (100 Yr.)
1,054 cfs (10 Yr.)
80
90
Elevation
3500
3460
3420
3380
3340
3300
423+00
431+00
439+00
447+00
455+00
463+00
471+00
479+00
487+00
495+00
503+00
511+00
519+00
527+00
Station



MOHAVE CHANNEL


MOHAVE CHANNEL
50
215' R/W
RAILWAY CHANNEL
U.S. 66
A.T.&S.F.R.R.
SEE PLATE 8
100
THOMPSON AVE.

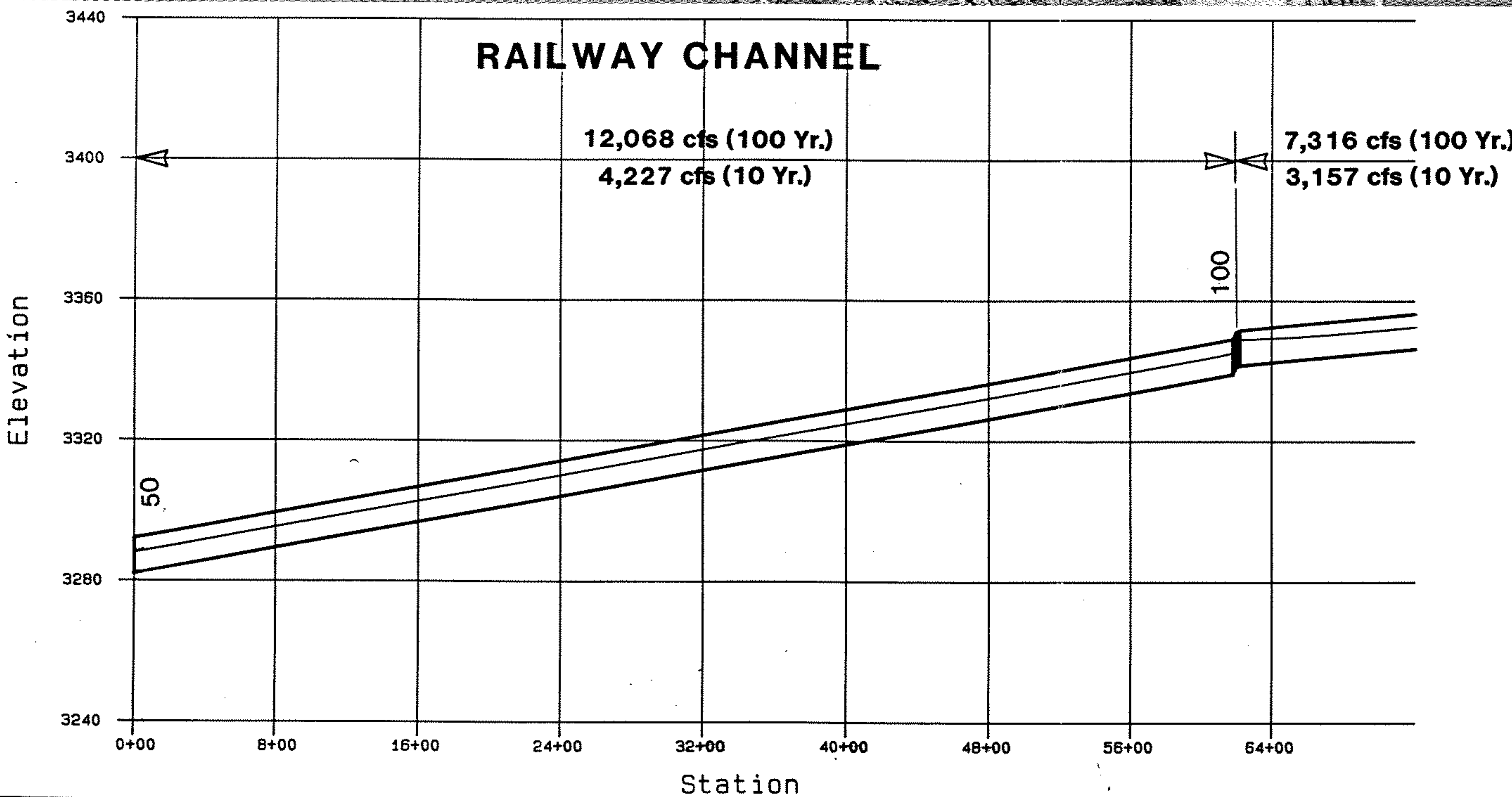

RAILWAY CHANNEL
12,068 cfs (100 Yr.)
4,227 cfs (10 Yr.)
7,316 cfs (100 Yr.)
3,157 cfs (10 Yr.)
100
50
Elevation
3440
3400
3360
3320
3280
3240
0+00
8+00
16+00
24+00
32+00
40+00
48+00
56+00
64+00
Station

PLATE 8

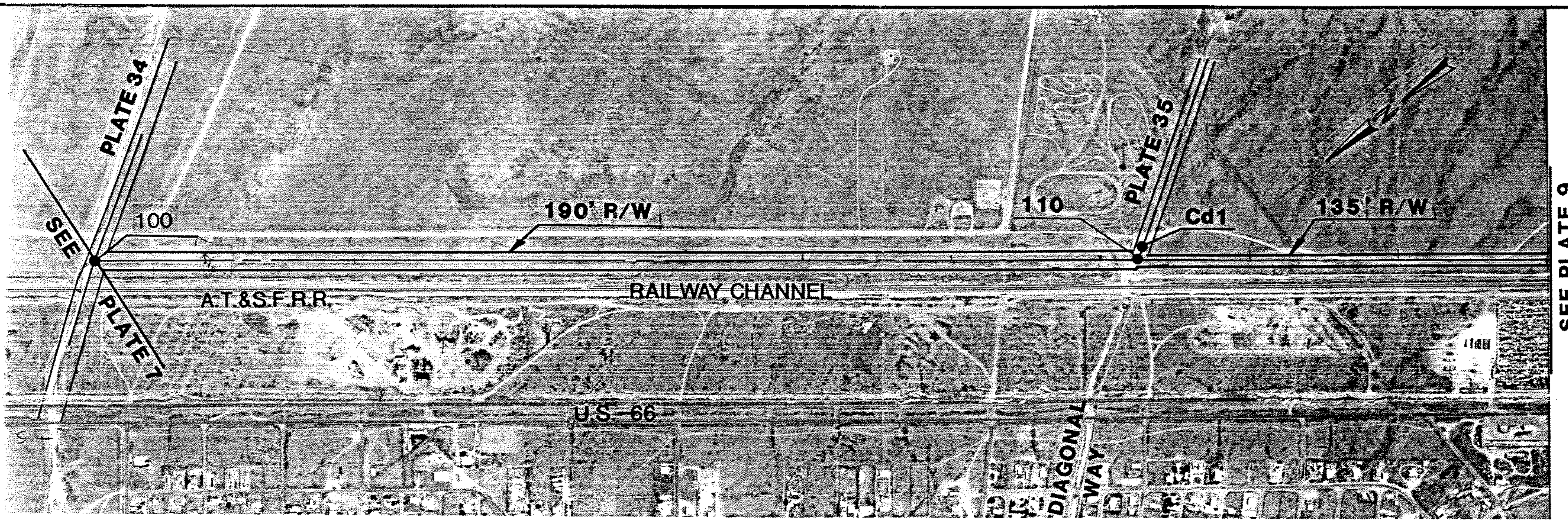
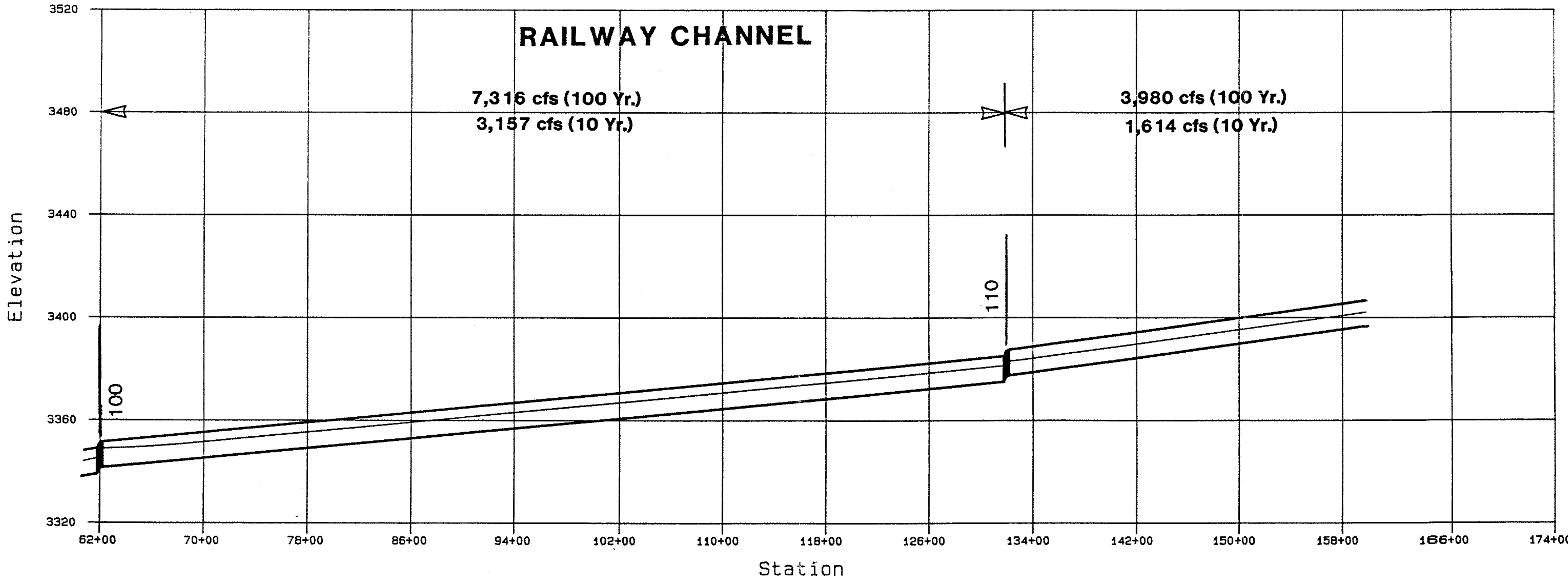
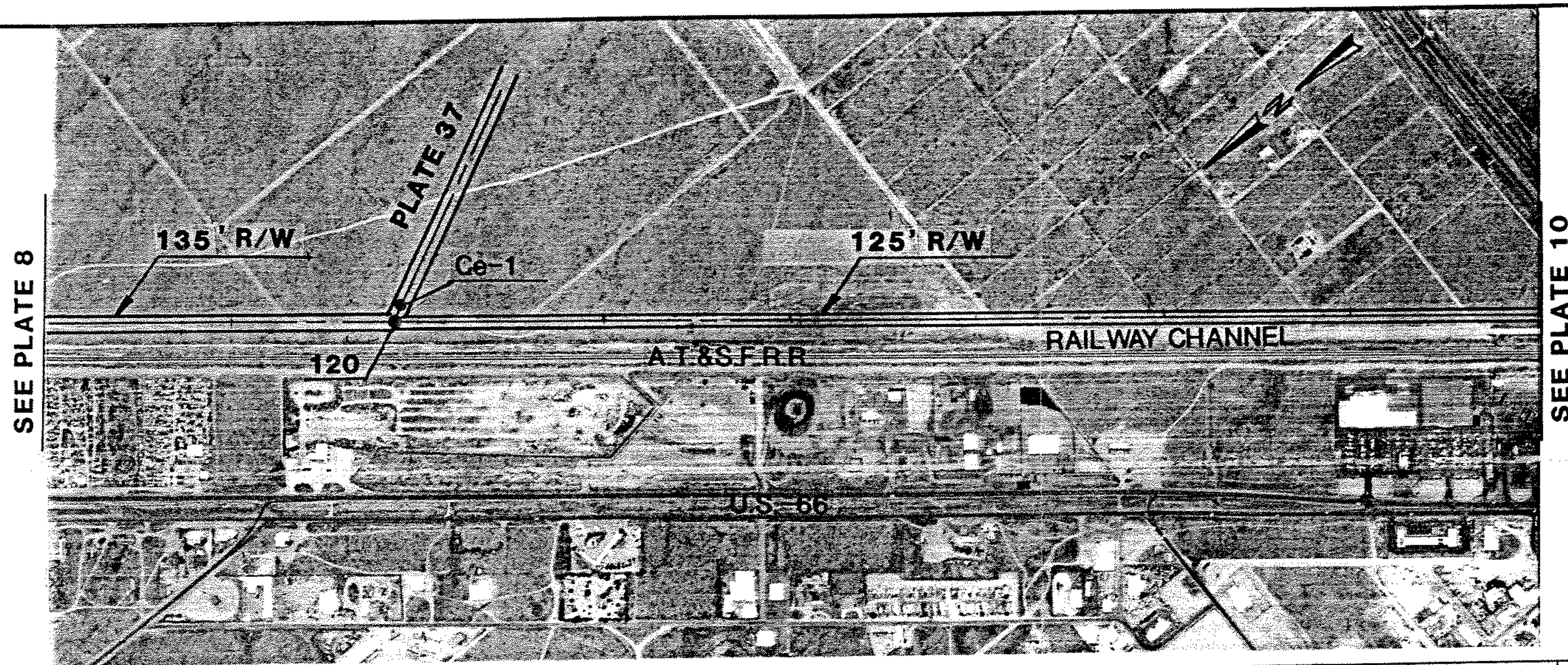


PLATE 34
SEE
PLATE 7
100
190' R/W
A.T.&S.F.R.R.
RAILWAY CHANNEL
110
PLATE 35
Cd1
135' R/W
N
SEE PLATE 9
U.S. 66
DIAGONAL WAY



RAILWAY CHANNEL
7,316 cfs (100 Yr.)
3,157 cfs (10 Yr.)
3,980 cfs (100 Yr.)
1,614 cfs (10 Yr.)
100
110
Elevation
3520
3480
3440
3400
3360
3320
Station
62+00
70+00
78+00
86+00
94+00
102+00
110+00
118+00
126+00
134+00
142+00
150+00
158+00
166+00
174+00

PLATE 9


SEE PLATE 8
135' R/W
PLATE 37
Ce-1
120
125' R/W
RAILWAY CHANNEL
A.T.&S.F.R.R.
U.S. 66
N
SEE PLATE 10

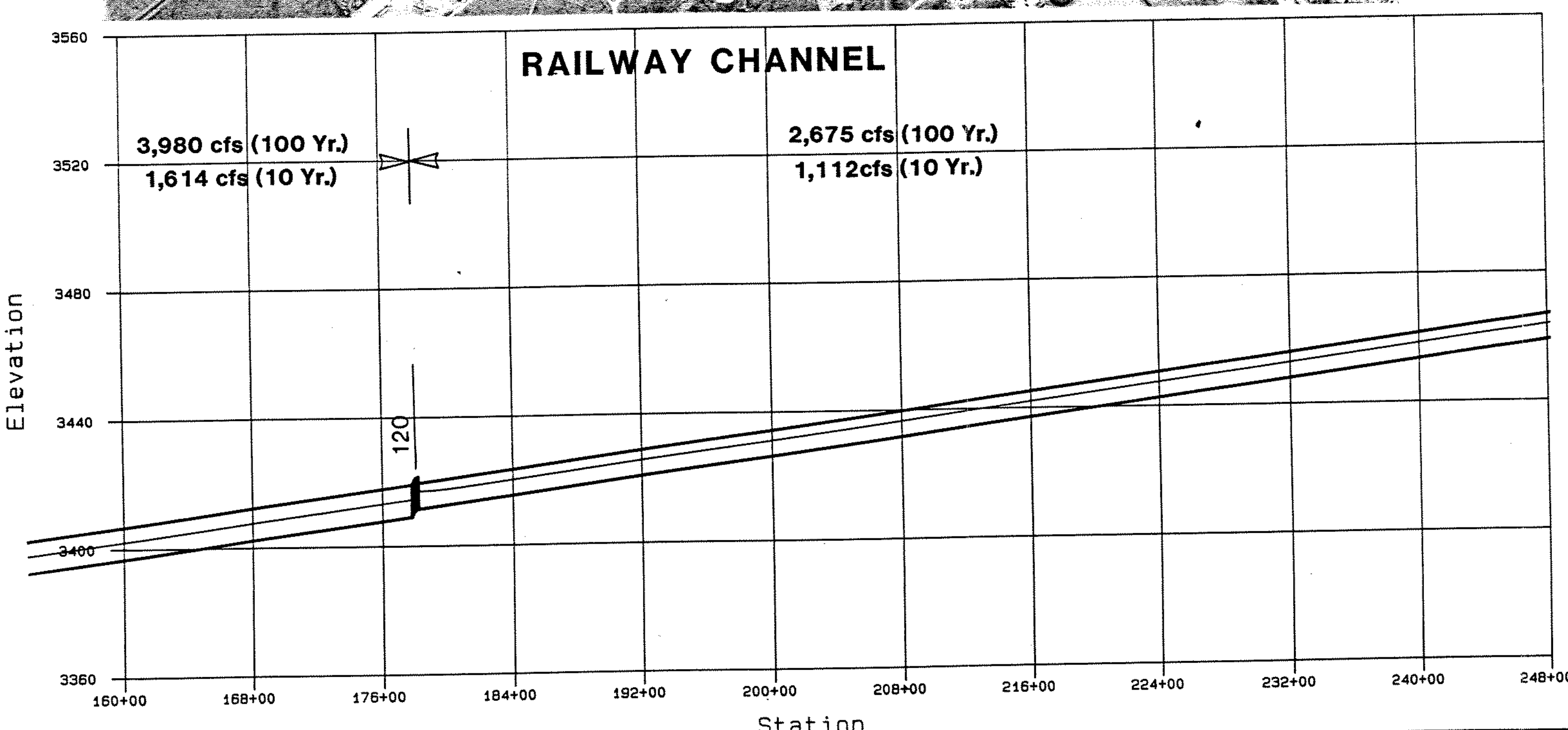
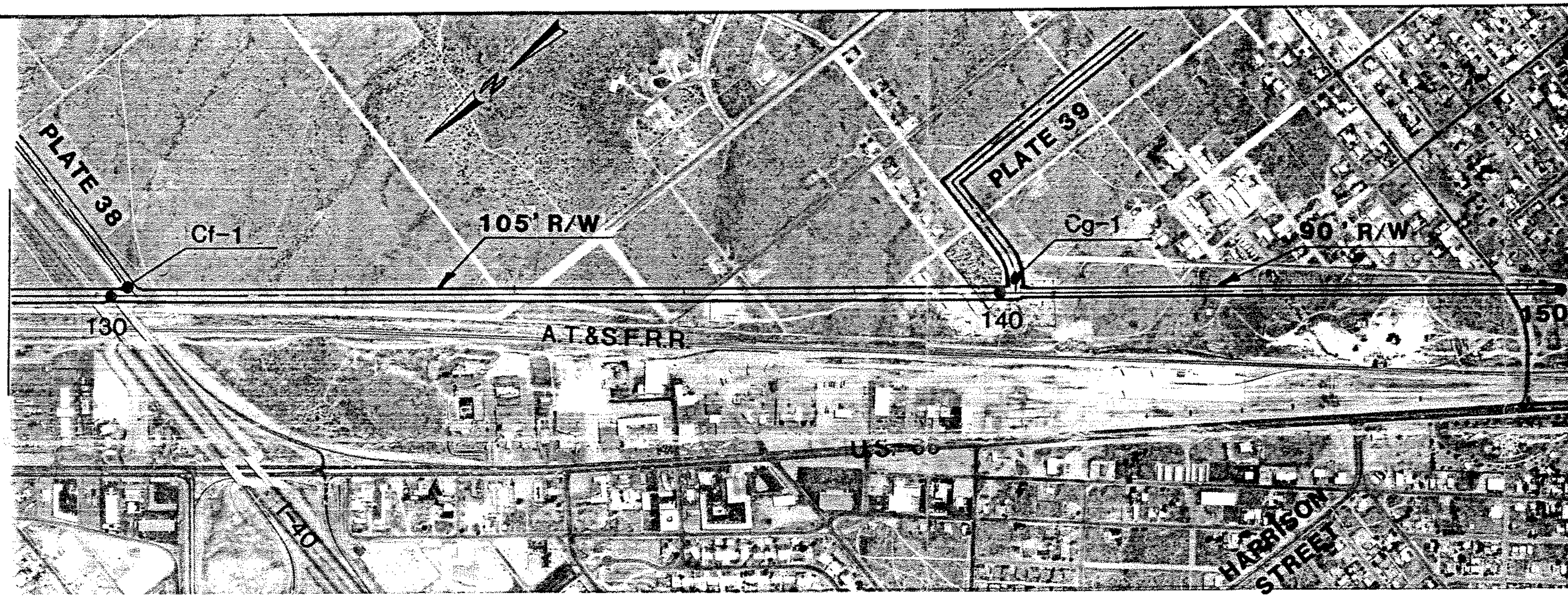

RAILWAY CHANNEL
3,980 cfs (100 Yr.)
1,614 cfs (10 Yr.)
2,675 cfs (100 Yr.)
1,112cfs (10 Yr.)
120
Elevation
3560
3520
3480
3440
3400
3360
160+00
168+00
176+00
184+00
192+00
200+00
208+00
216+00
224+00
232+00
240+00
248+00
Station

PLATE 10


N
SEE PLATE 9
PLATE 38
PLATE 39
Cf-1
105' R/W
Cg-1
90' R/W
130
140
150
A.T.&S.F.R.R.
U.S. 66
I-40
HARRISON STREET

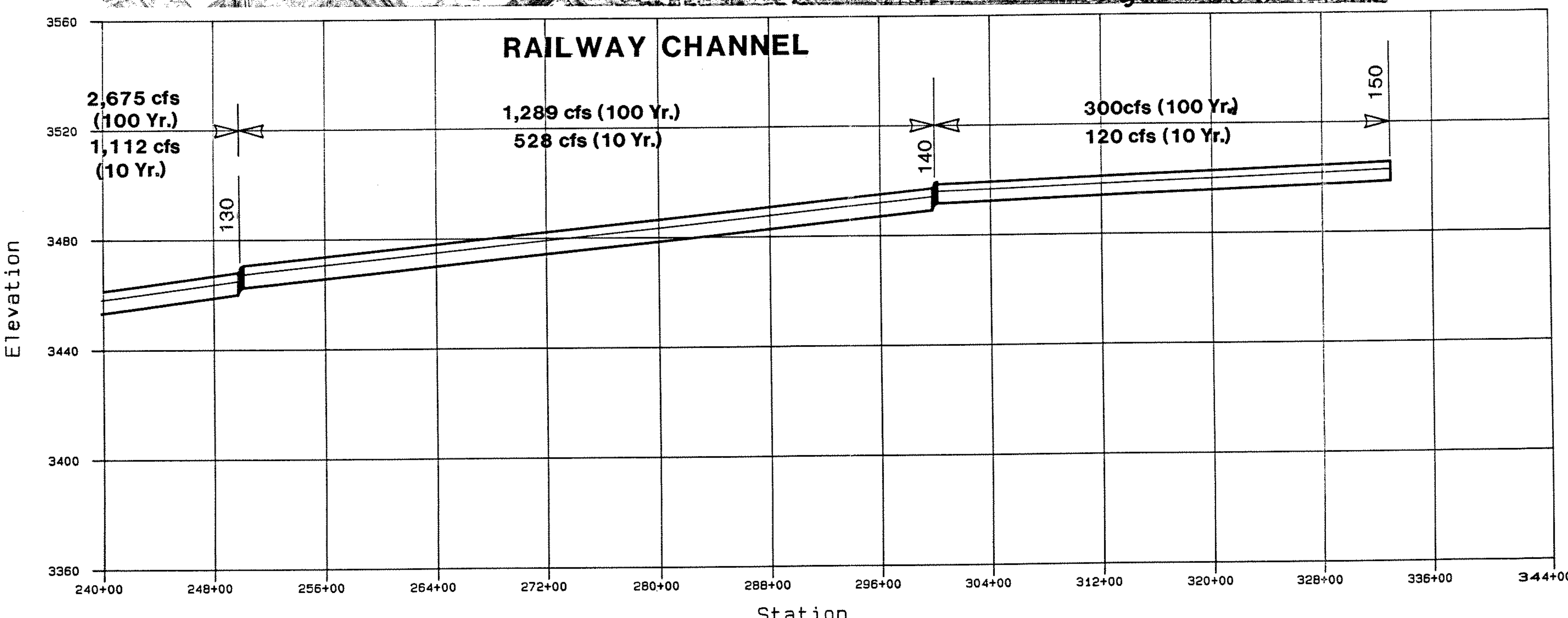
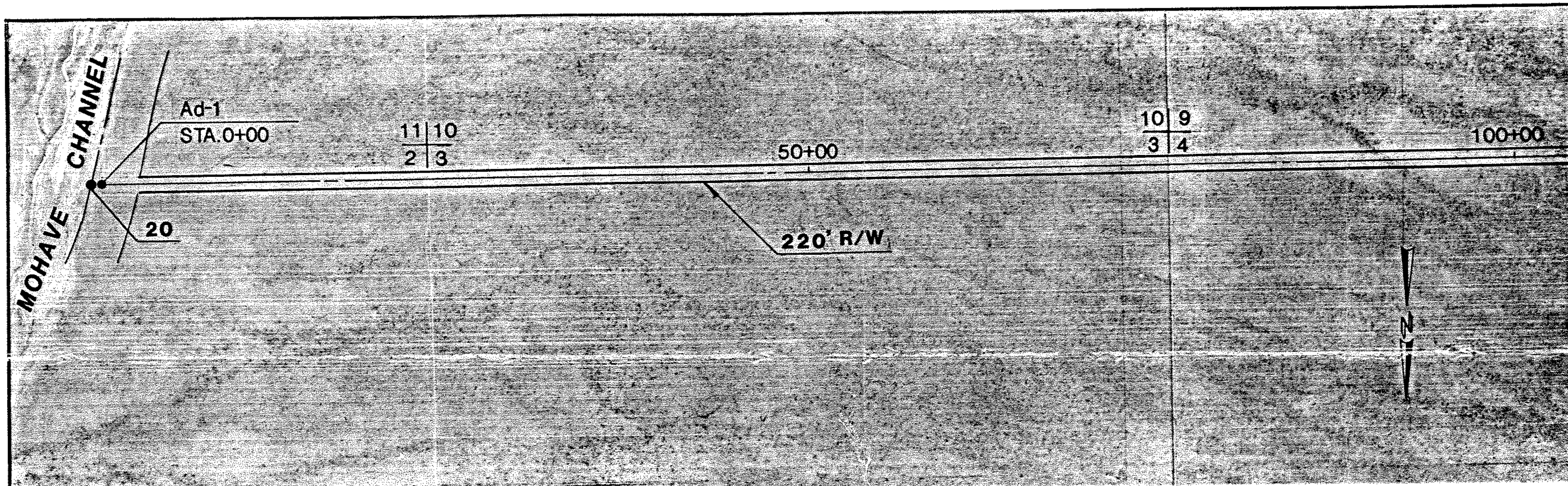
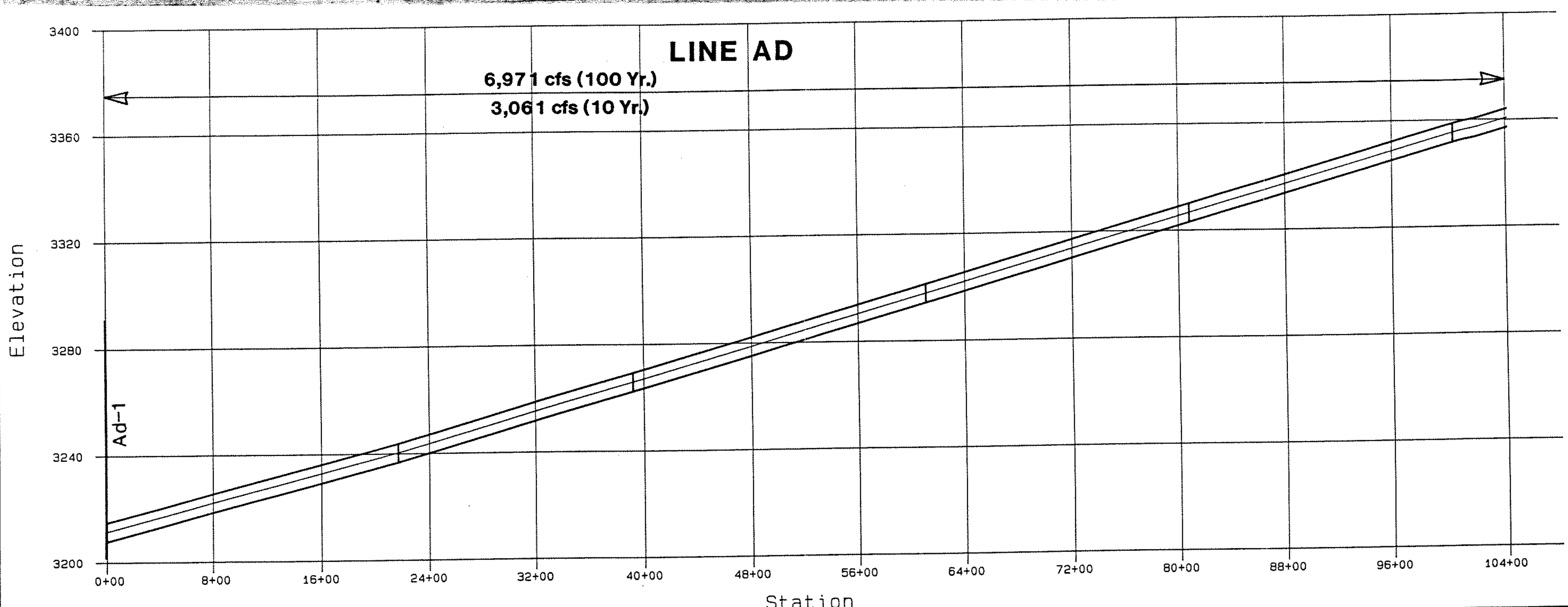
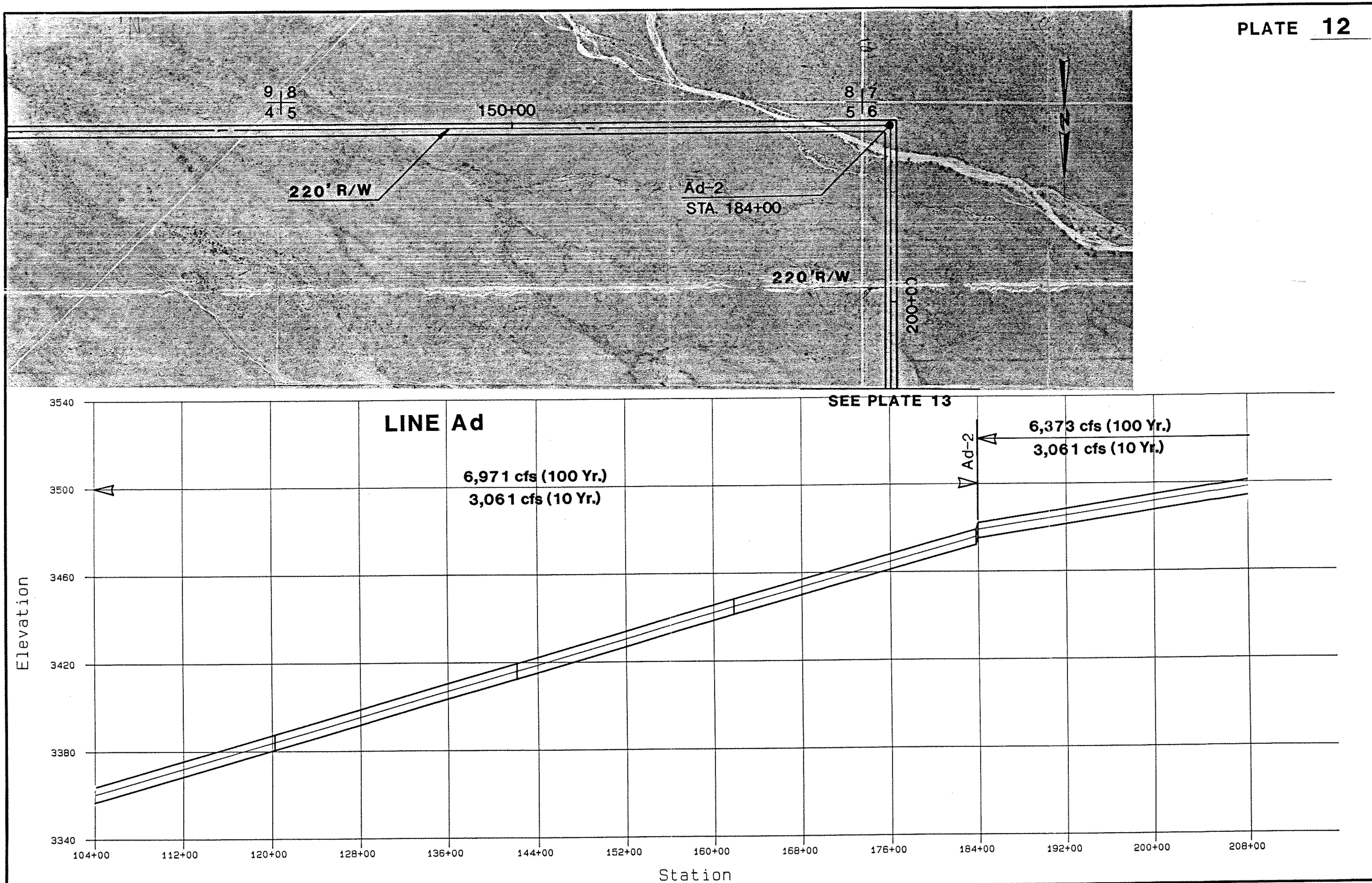

RAILWAY CHANNEL
2,675 cfs (100 Yr.)
1,112 cfs (10 Yr.)
1,289 cfs (100 Yr.)
528 cfs (10 Yr.)
300cfs (100 Yr.)
120 cfs (10 Yr.)
130
140
150
Elevation
3560
3520
3480
3440
3400
3360
Station
240+00
248+00
256+00
264+00
272+00
280+00
288+00
296+00
304+00
312+00
320+00
328+00
336+00
344+00

PLATE 11



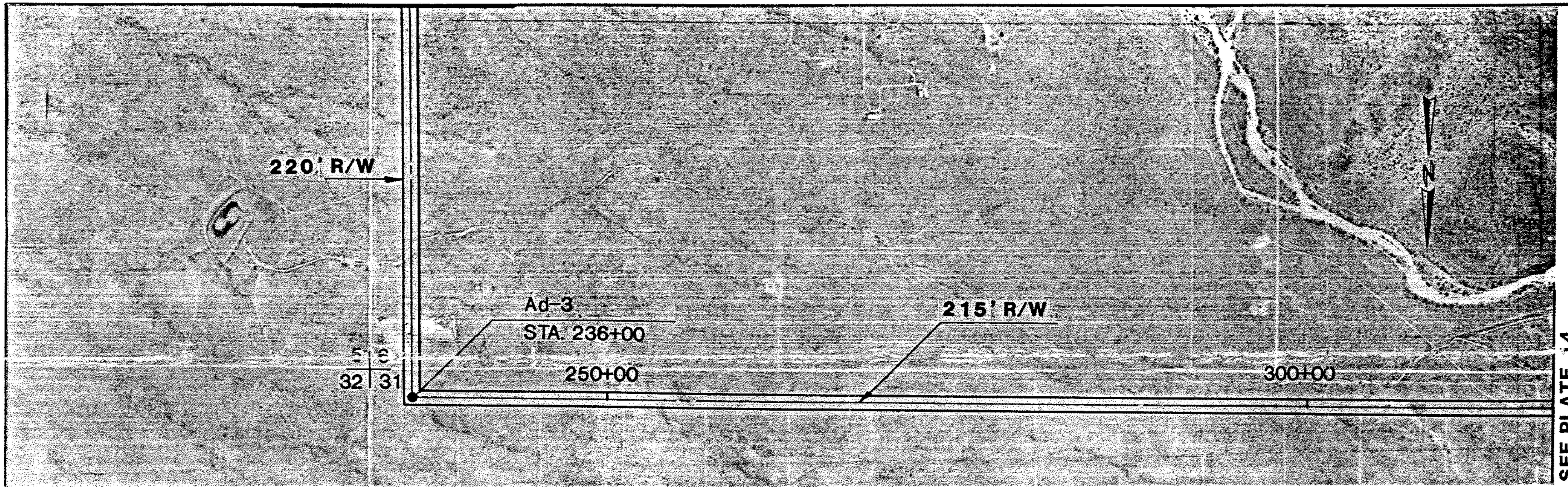


Boyle Engineering Corporation


SEE PLATE 11
9 8
4 5
150+00
8 7
5 6
220' R/W
Ad-2
STA. 184+00
220' R/W
200+00
SEE PLATE 13
LINE Ad
Ad-2
6,373 cfs (100 Yr.)
3,061 cfs (10 Yr.)
6,971 cfs (100 Yr.)
3,061 cfs (10 Yr.)
Elevation
3540
3500
3460
3420
3380
3340
104+00
112+00
120+00
128+00
136+00
144+00
152+00
160+00
168+00
176+00
184+00
192+00
200+00
208+00
Station

SEE PLATE 12

PLATE 13



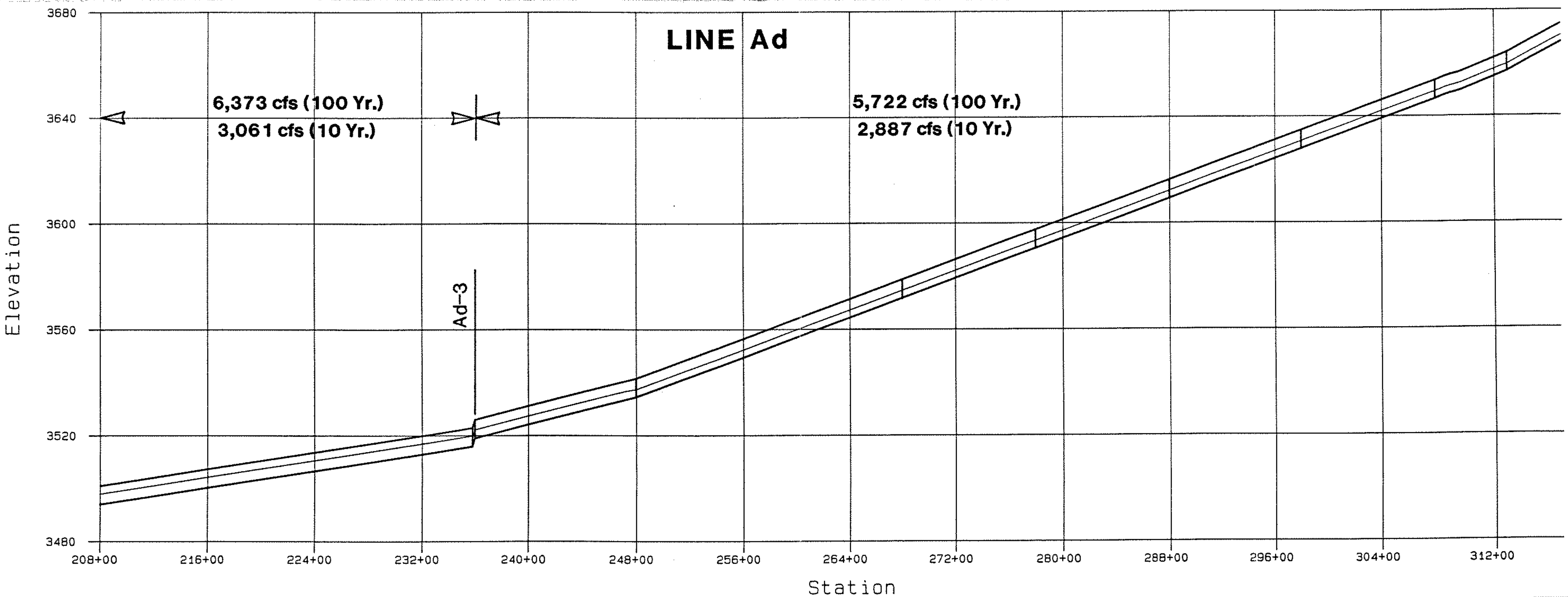
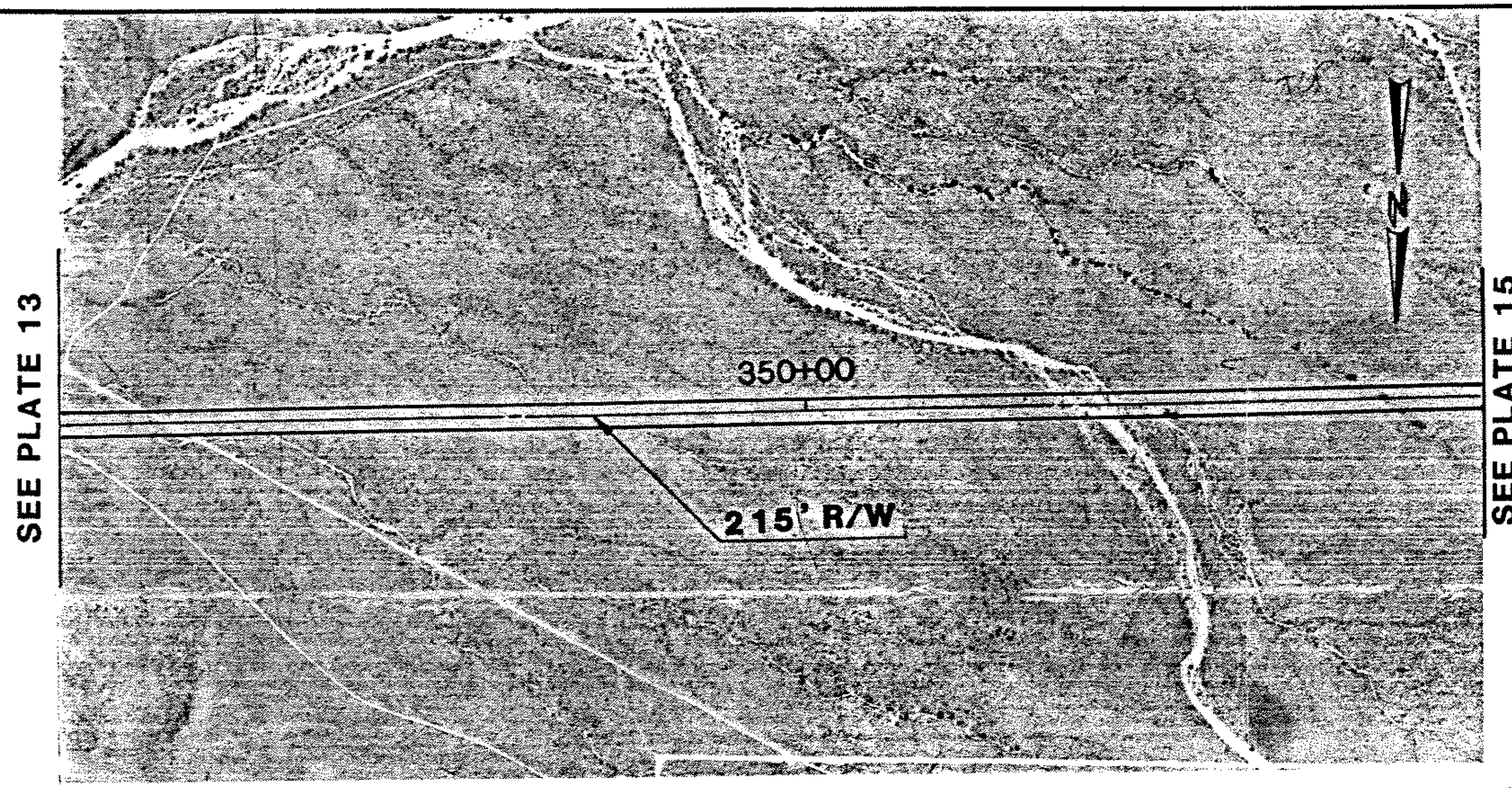
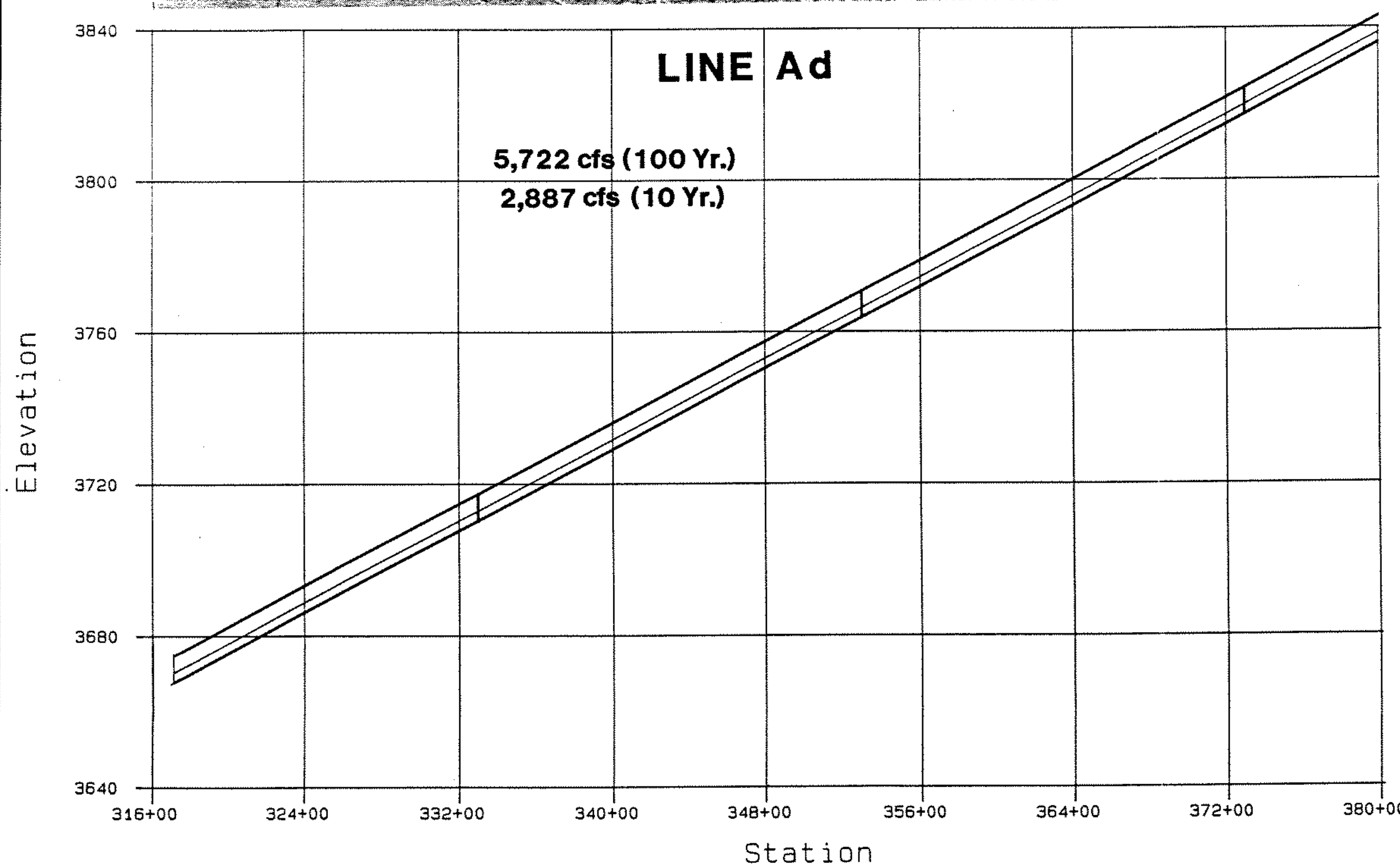


PLATE 14

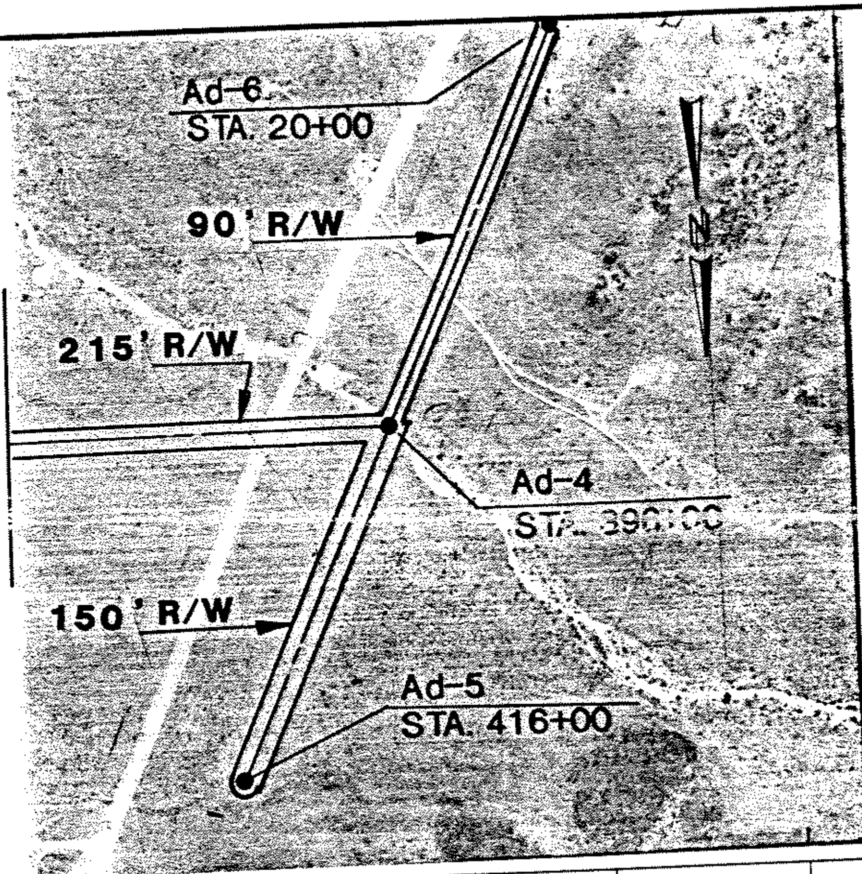


SEE PLATE 13
350+00
215' R/W
N
SEE PLATE 15

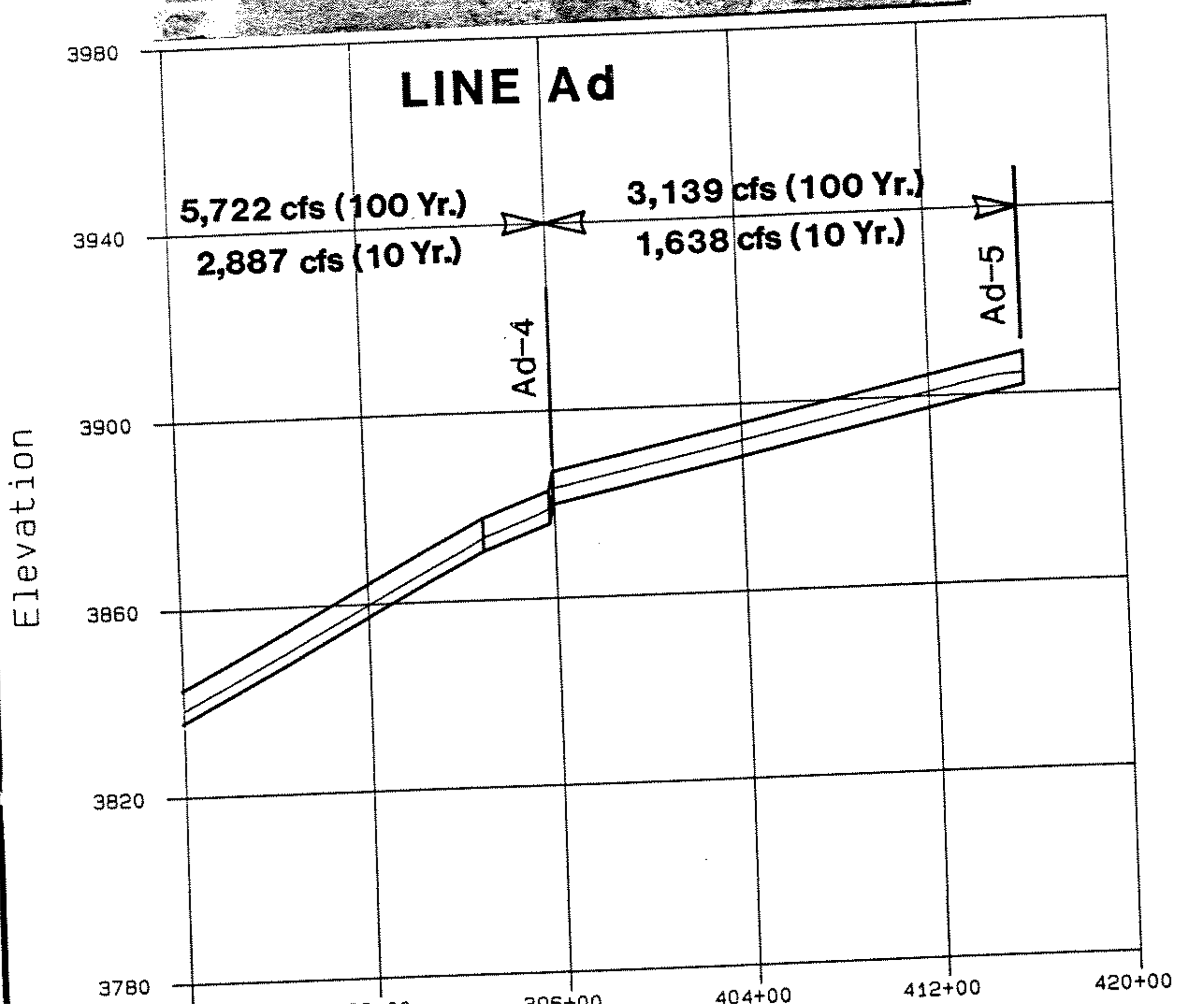


LINE Ad
5,722 cfs (100 Yr.)
2,887 cfs (10 Yr.)
Elevation
3840
3800
3760
3720
3680
3640
316+00
324+00
332+00
340+00
348+00
356+00
364+00
372+00
380+00
Station

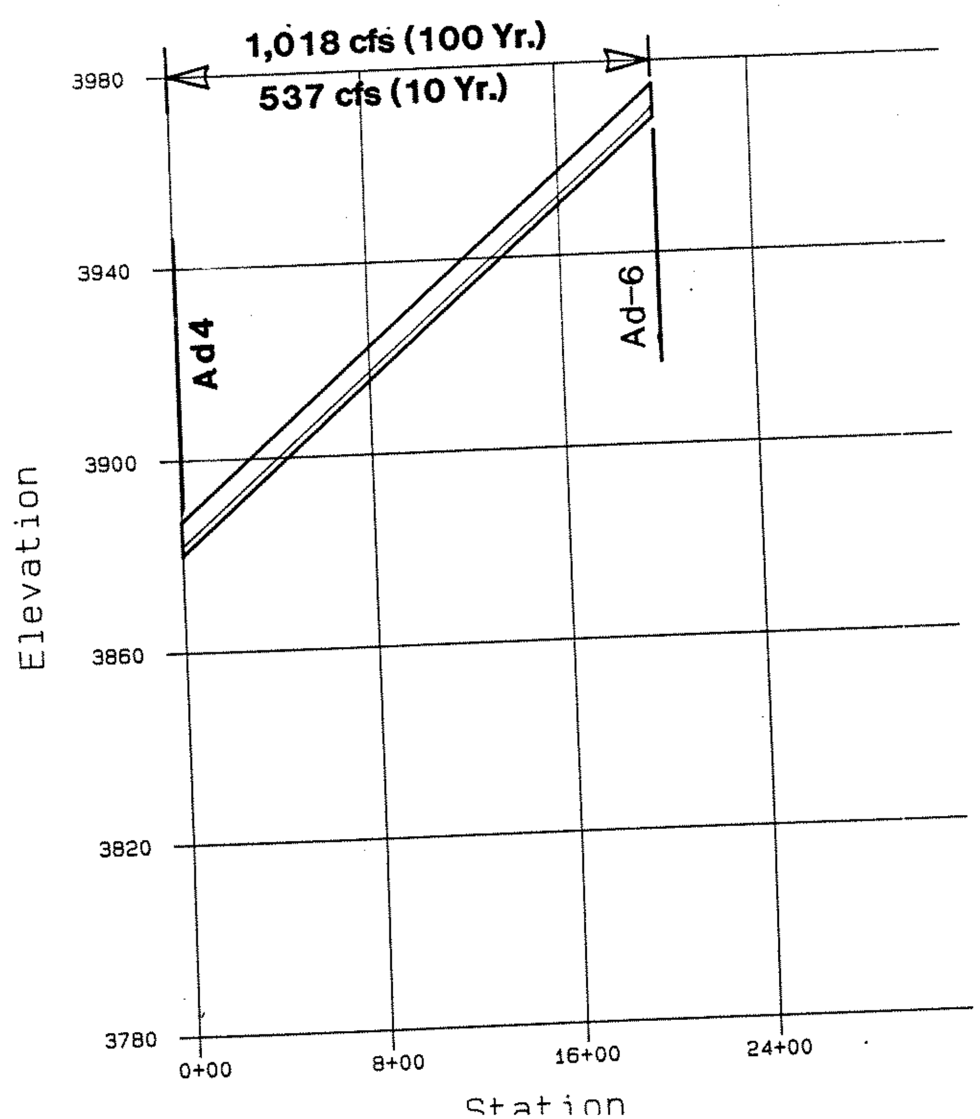
PLATE 15



Ad-6
STA. 20+00
90' R/W
215' R/W
SEE PLATE 14
Ad-4
150' R/W
Ad-5
STA. 416+00
N

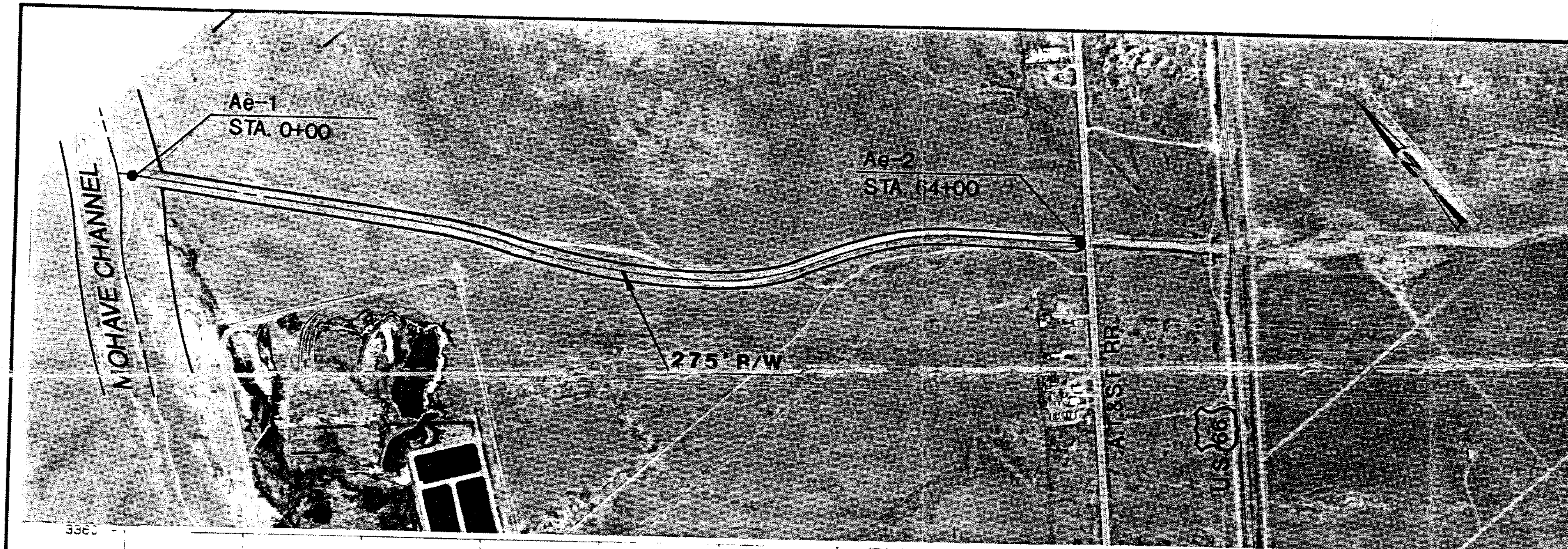


LINE Ad
5,722 cfs (100 Yr.)
2,887 cfs (10 Yr.)
3,139 cfs (100 Yr.)
1,638 cfs (10 Yr.)
Ad-4
Ad-5
Elevation
3980
3940
3900
3860
3820
3780
404+00
412+00
420+00



1,018 cfs (100 Yr.)
537 cfs (10 Yr.)
Ad4
Ad-6
Elevation
3980
3940
3900
3860
3820
3780
0+00
8+00
16+00
24+00
Station

PLATE 16


Ae-1
STA. 0+00
Ae-2
STA. 64+00
MOHAVE CHANNEL
275' R/W
A.T.&S.F. RR.
U.S. 66

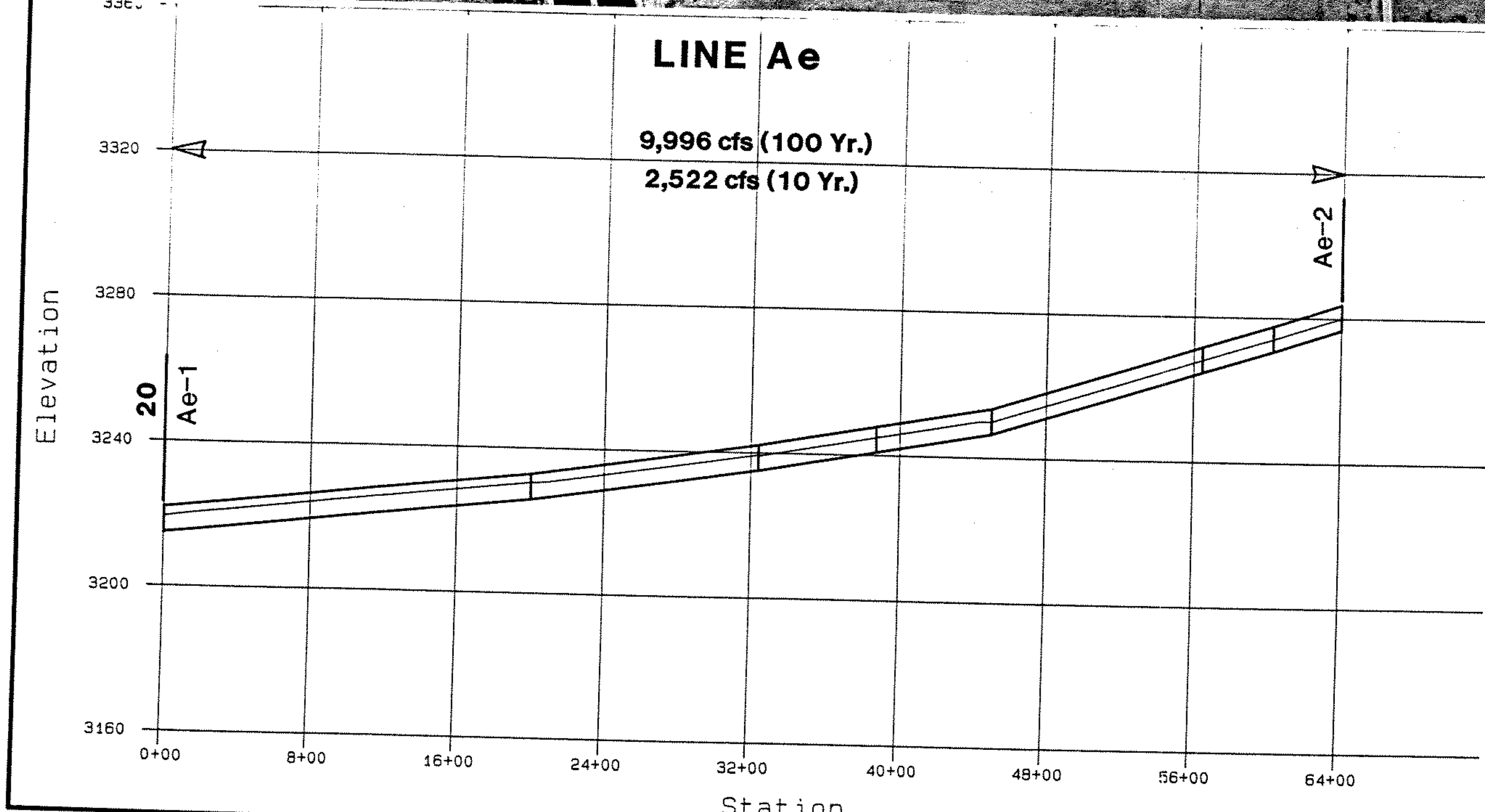

LINE Ae
9,996 cfs (100 Yr.)
2,522 cfs (10 Yr.)
Ae-1
Ae-2
20
Elevation
3320
3280
3240
3200
3160
0+00
8+00
16+00
24+00
32+00
40+00
48+00
56+00
64+00
Station

PLATE 17

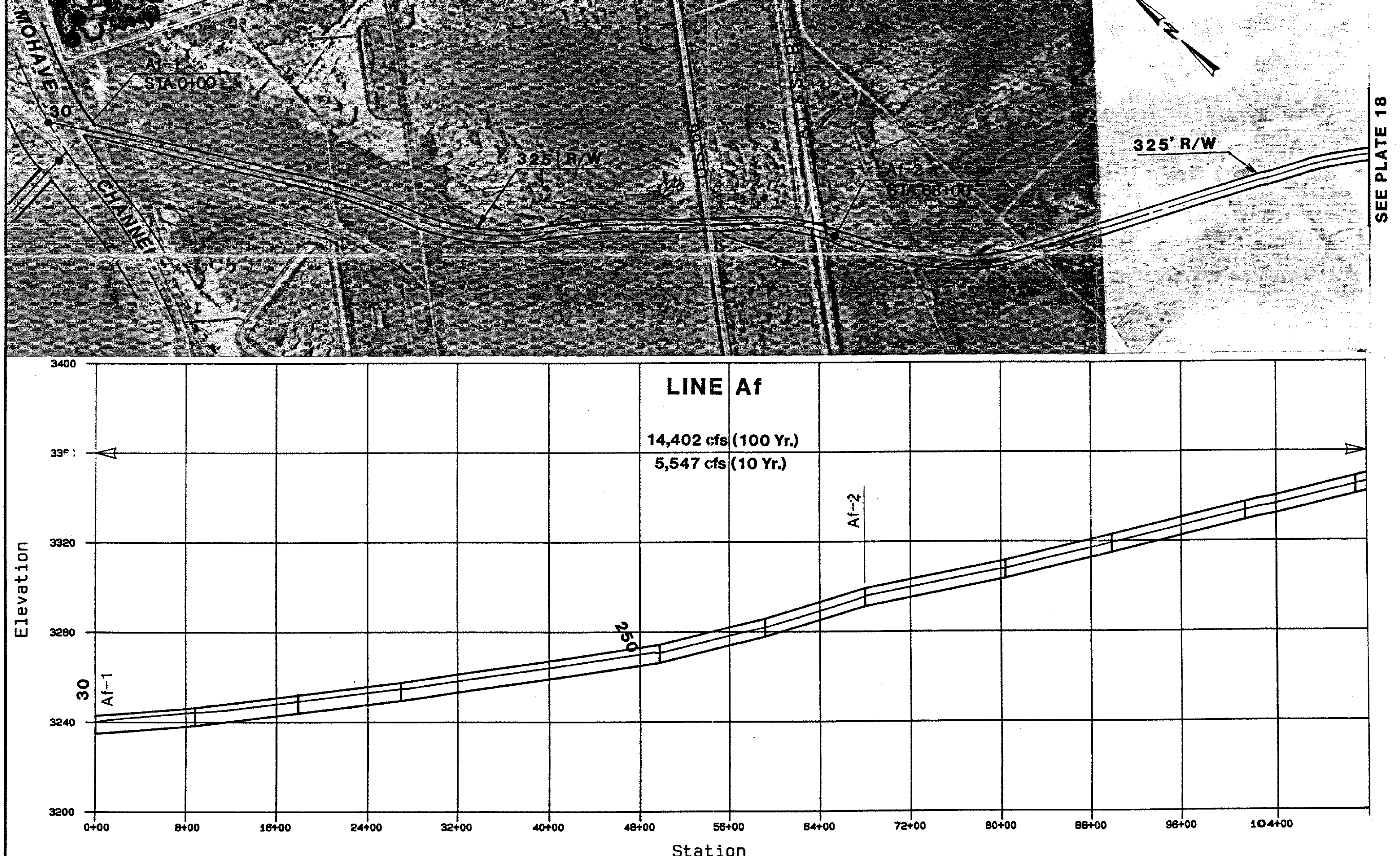


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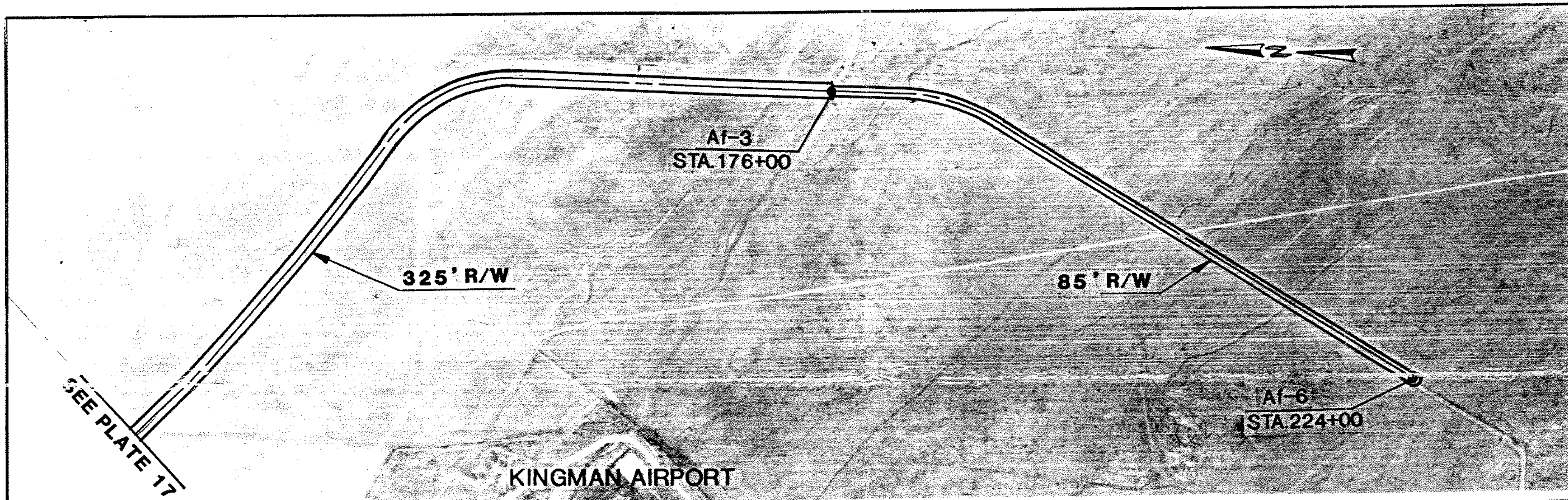
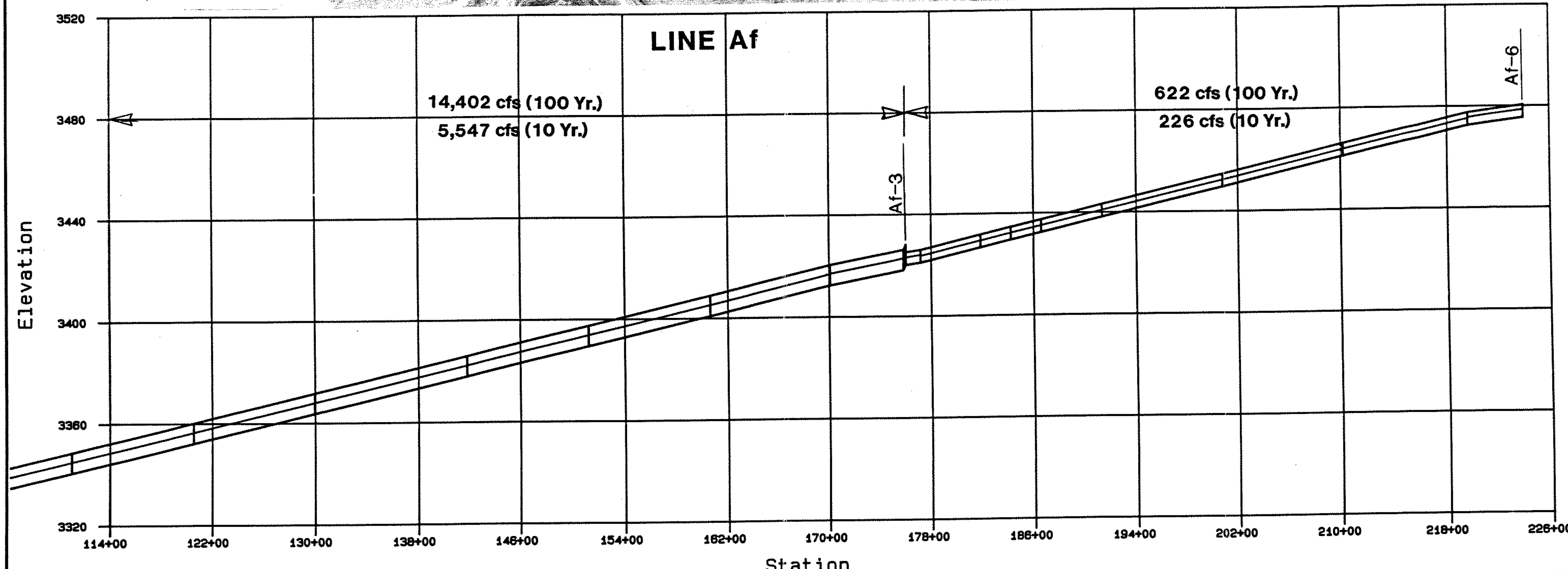
PLATE 18





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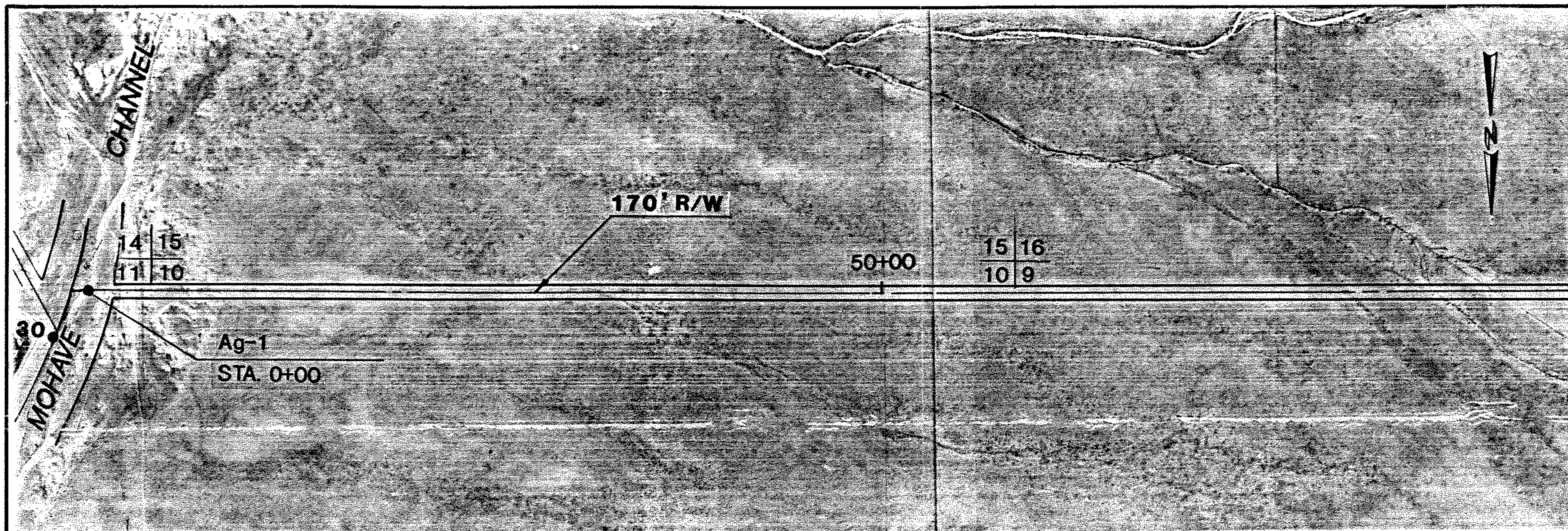
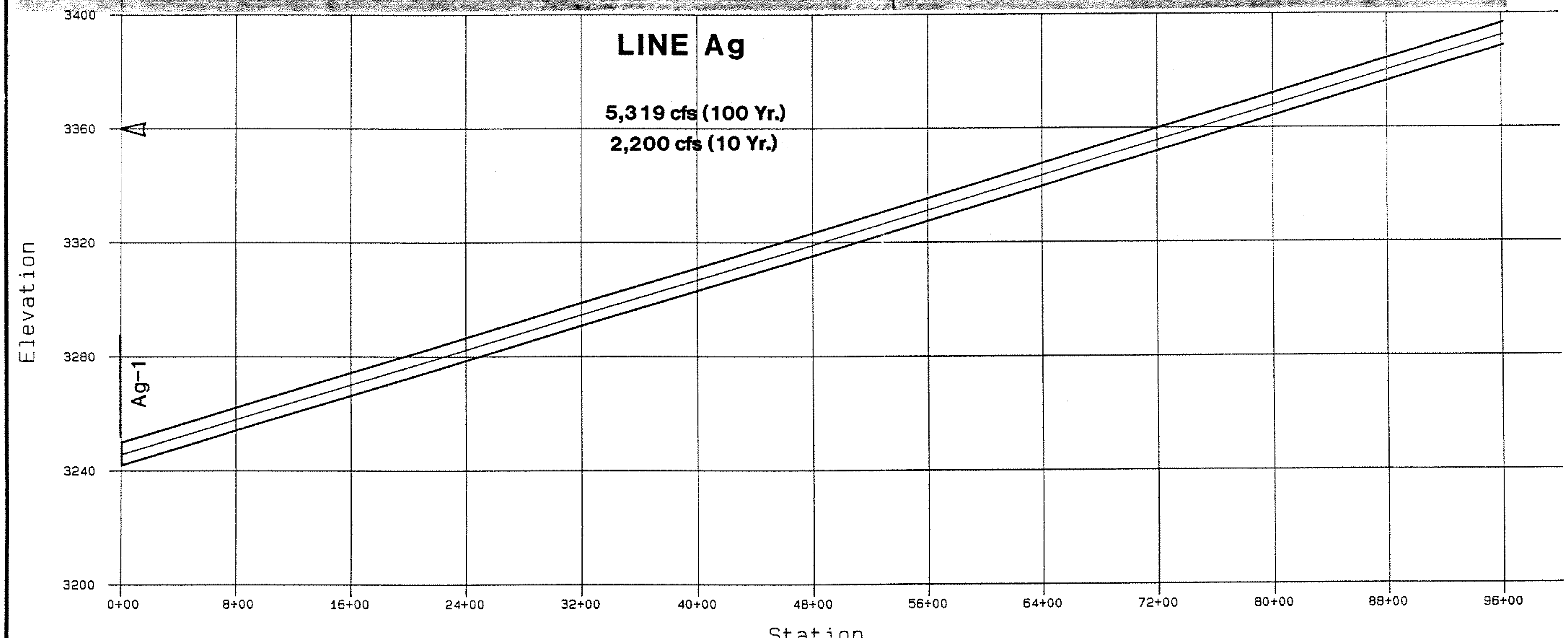


SEE PLATE 20



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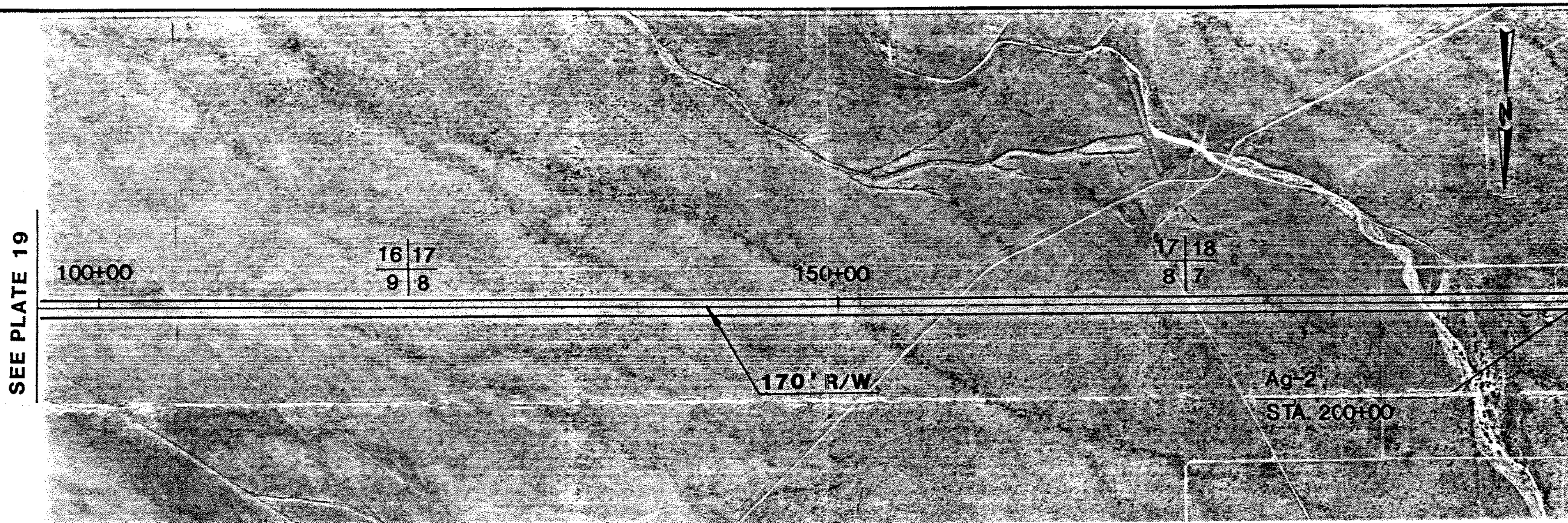
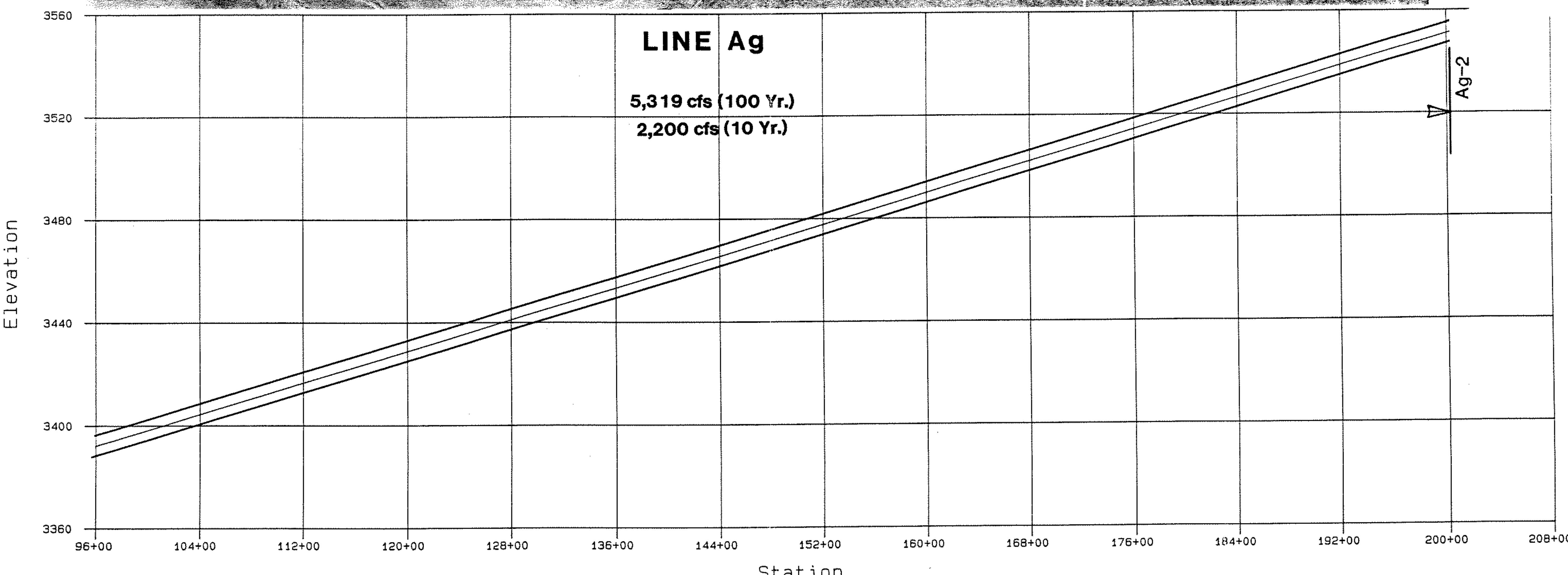
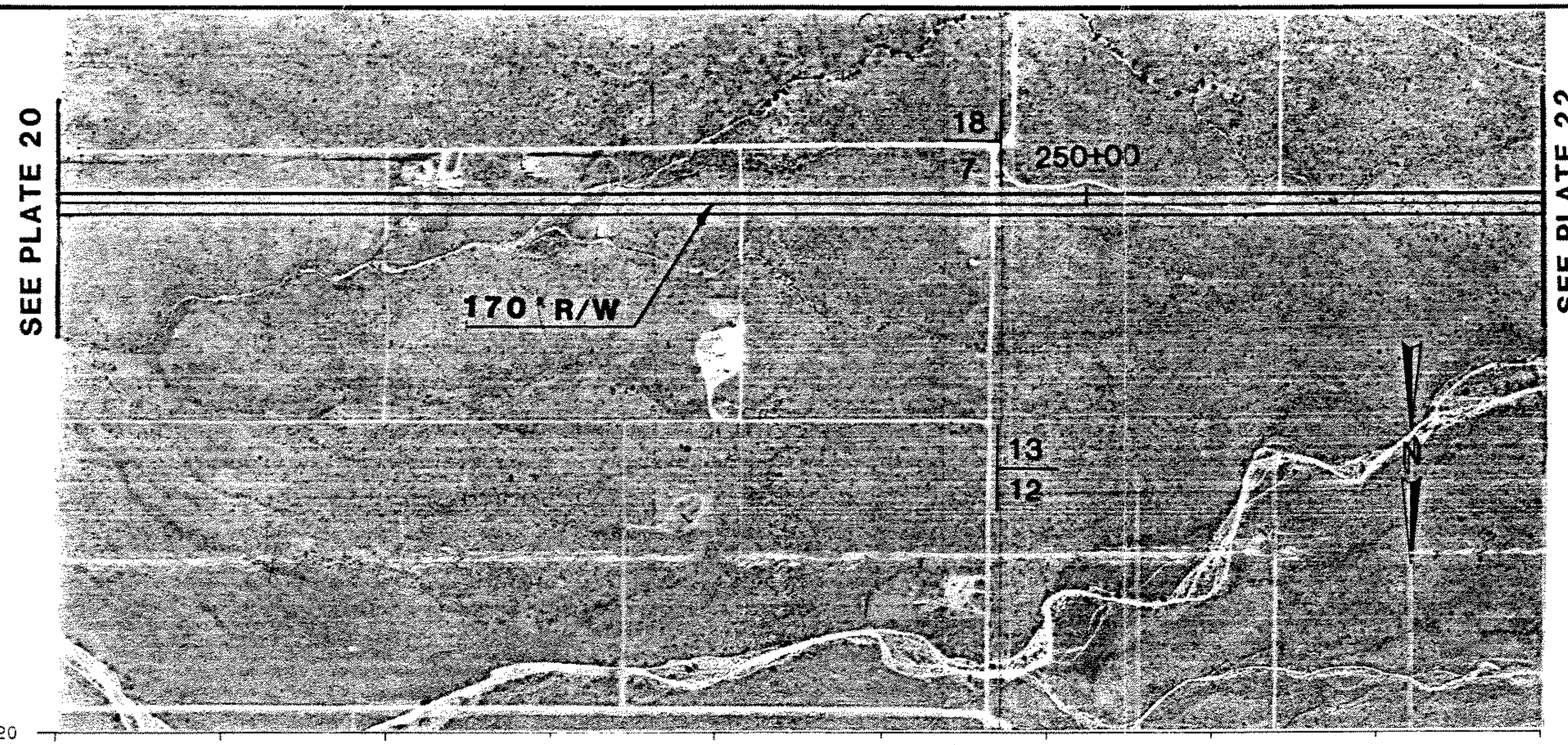

SEE PLATE 19
100+00
16 17
9 8
150+00
17 18
8 7
170' R/W.
Ag-2
STA. 200+00
N
SEE PLATE 21


LINE Ag
5,319 cfs (100 Yr.)
2,200 cfs (10 Yr.)
Ag-2
Elevation
3560
3520
3480
3440
3400
3360
96+00
104+00
112+00
120+00
128+00
136+00
144+00
152+00
160+00
168+00
176+00
184+00
192+00
200+00
208+00
Station


SEE PLATE 20
SEE PLATE 22
18
7
250+00
170' R/W
13
12
N

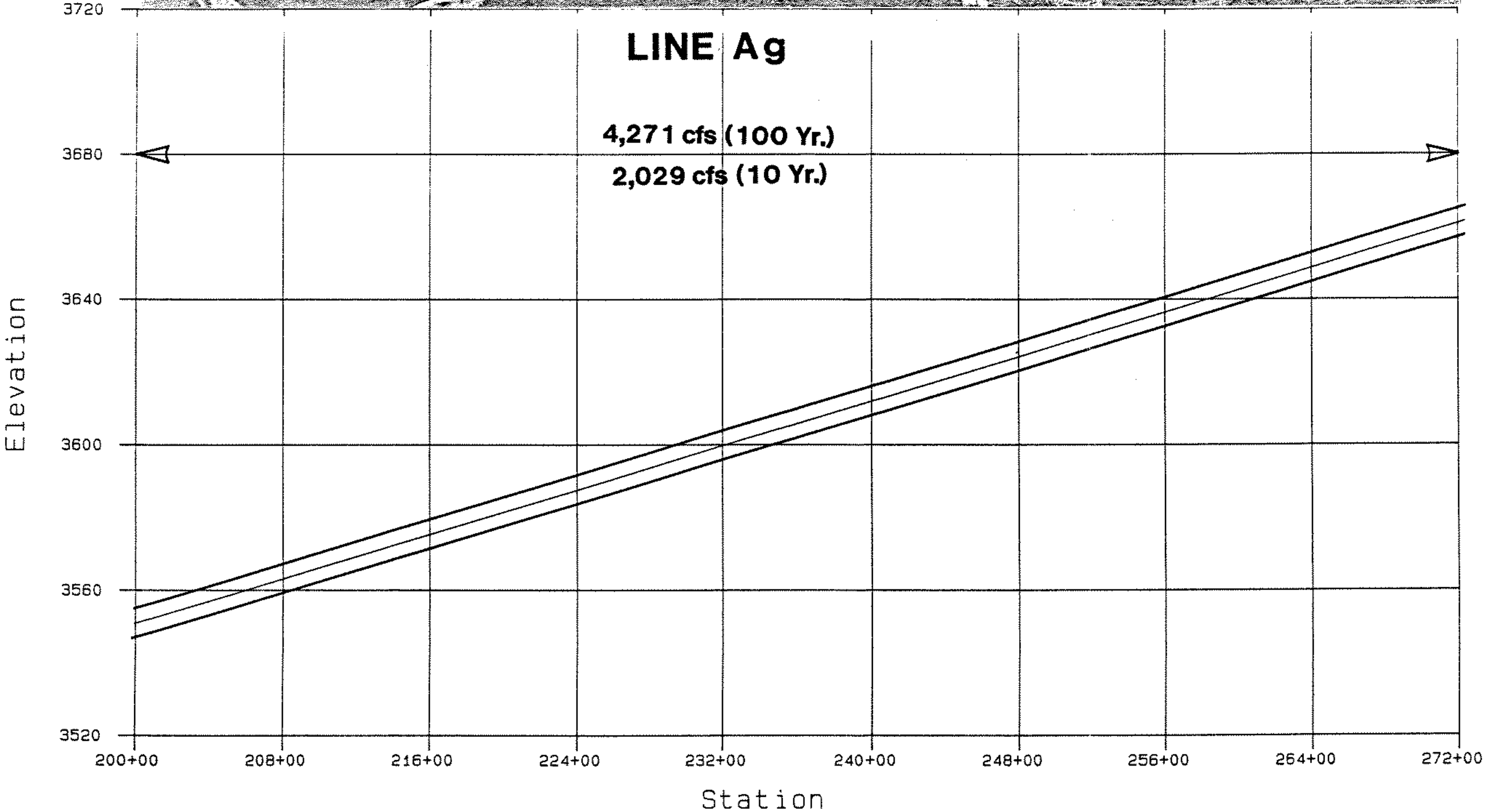
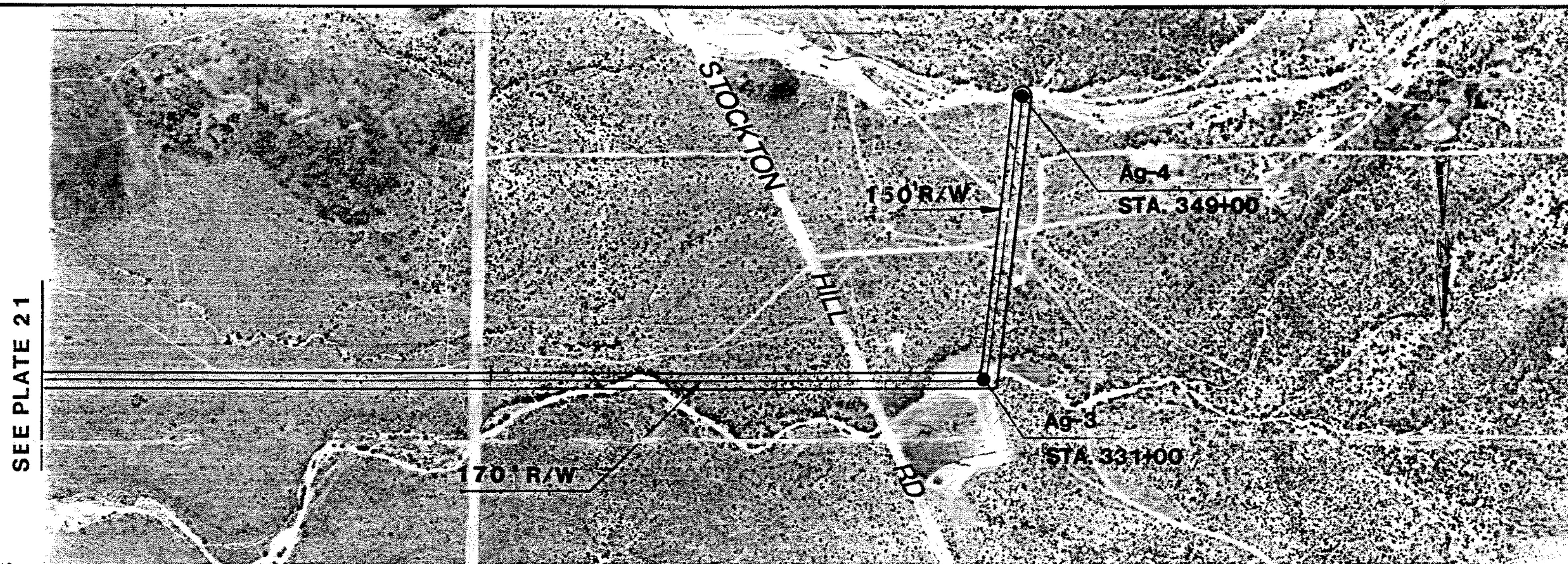

LINE Ag
4,271 cfs (100 Yr.)
2,029 cfs (10 Yr.)
Elevation
3720
3680
3640
3600
3560
3520
Station
200+00
208+00
216+00
224+00
232+00
240+00
248+00
256+00
264+00
272+00

PLATE 22



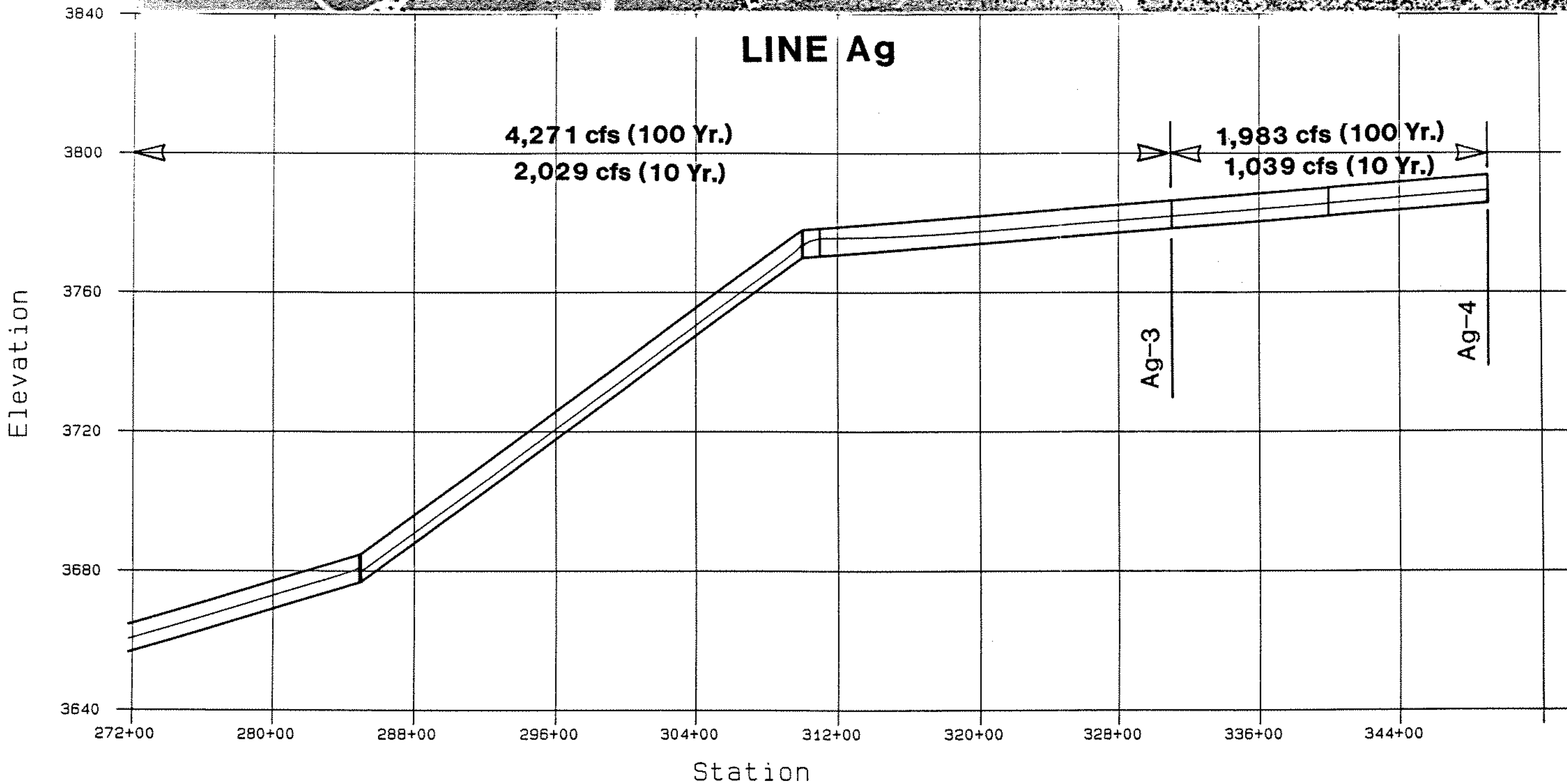


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PLATE 23

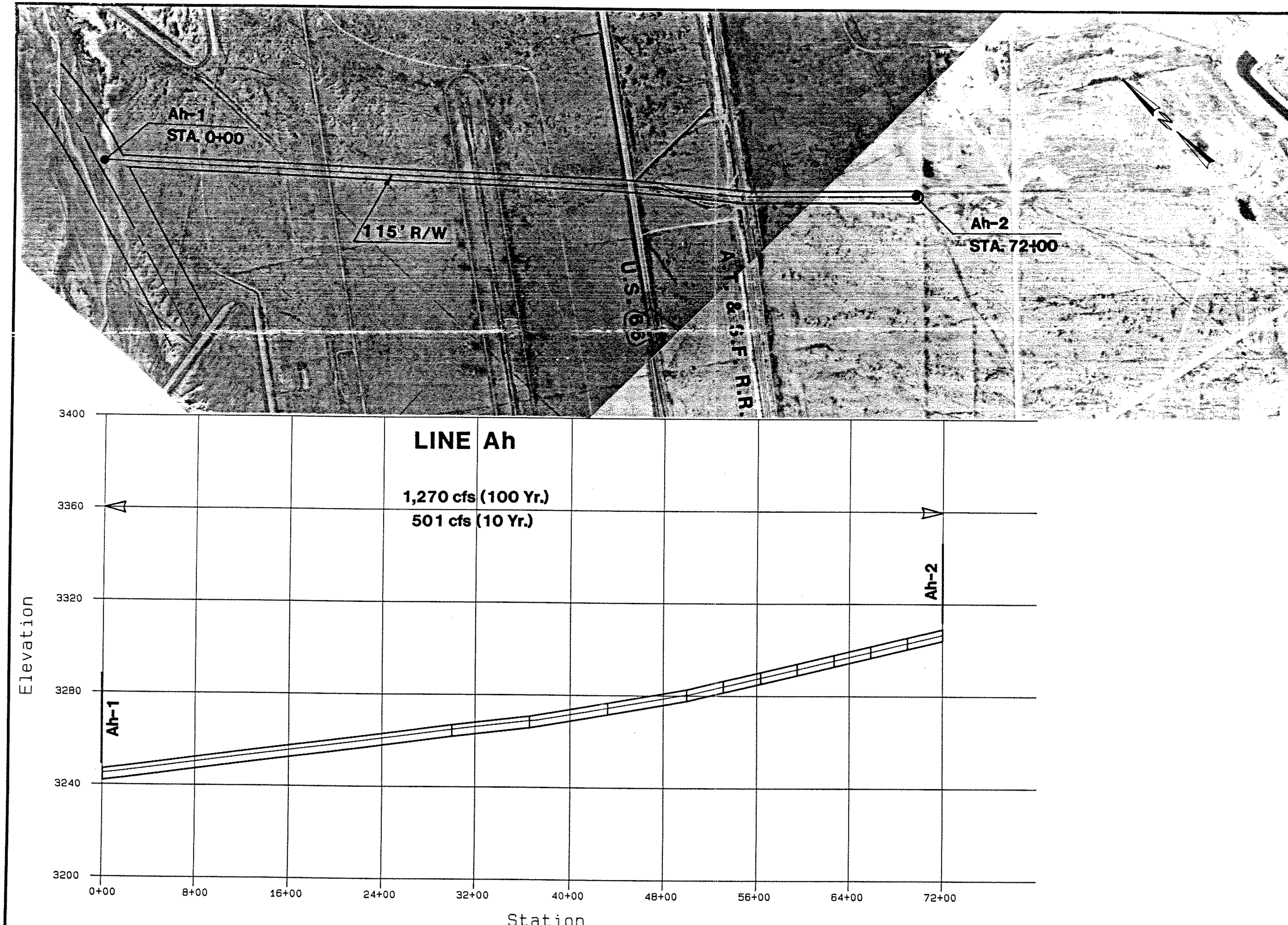
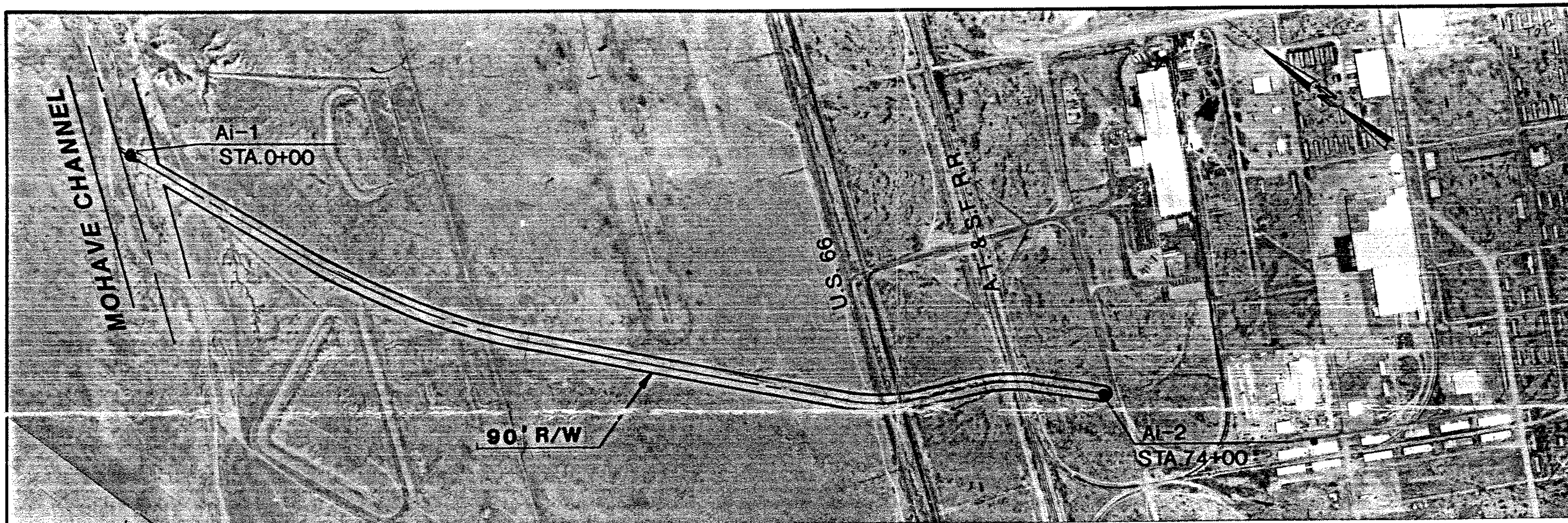

Ah-1
STA. 0+00
115' R/W
U.S. 68
A.T. & S.F. R.R.
Ah-2
STA. 72+00
LINE Ah
1,270 cfs (100 Yr.)
501 cfs (10 Yr.)
Ah-1
Ah-2
Elevation
3400
3360
3320
3280
3240
3200
0+00
8+00
16+00
24+00
32+00
40+00
48+00
56+00
64+00
72+00
Station

PLATE 24



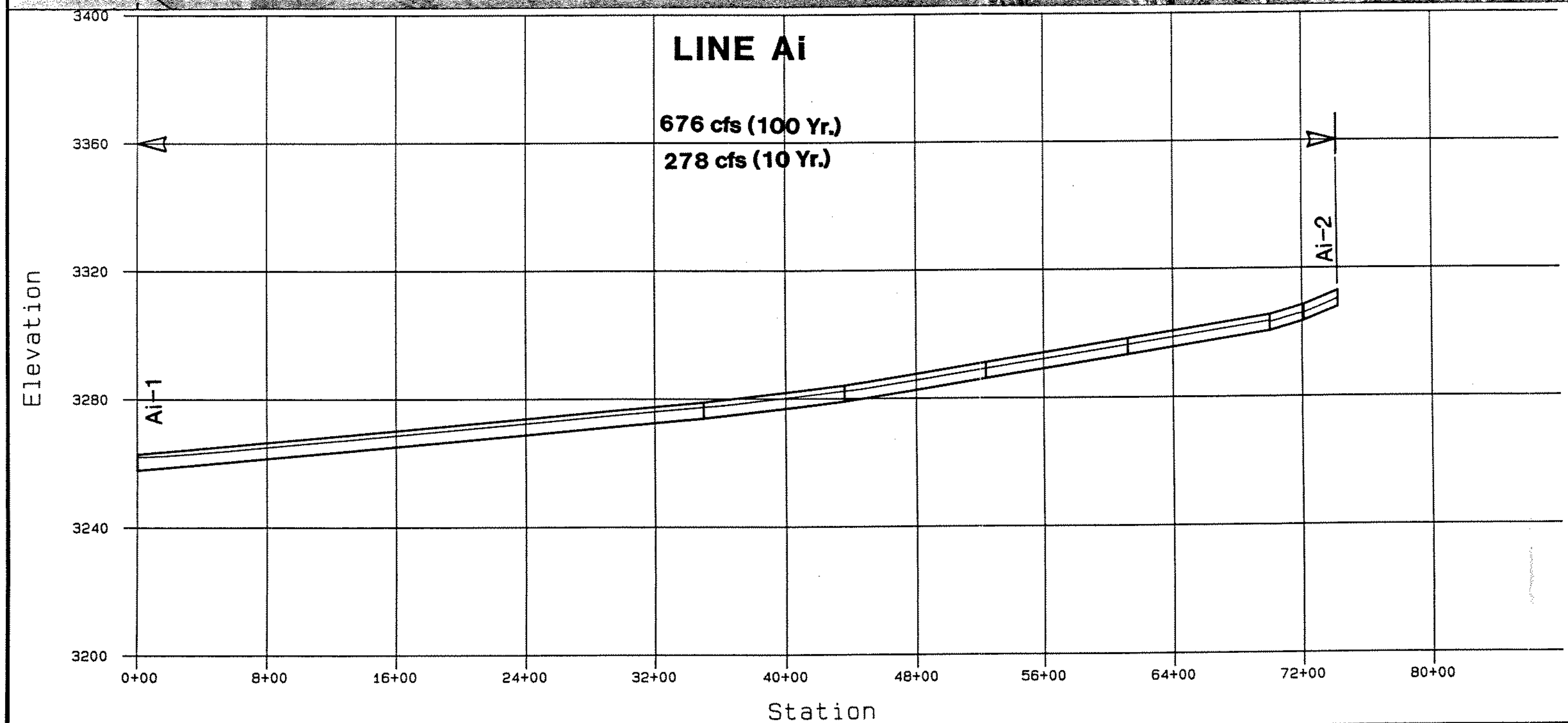


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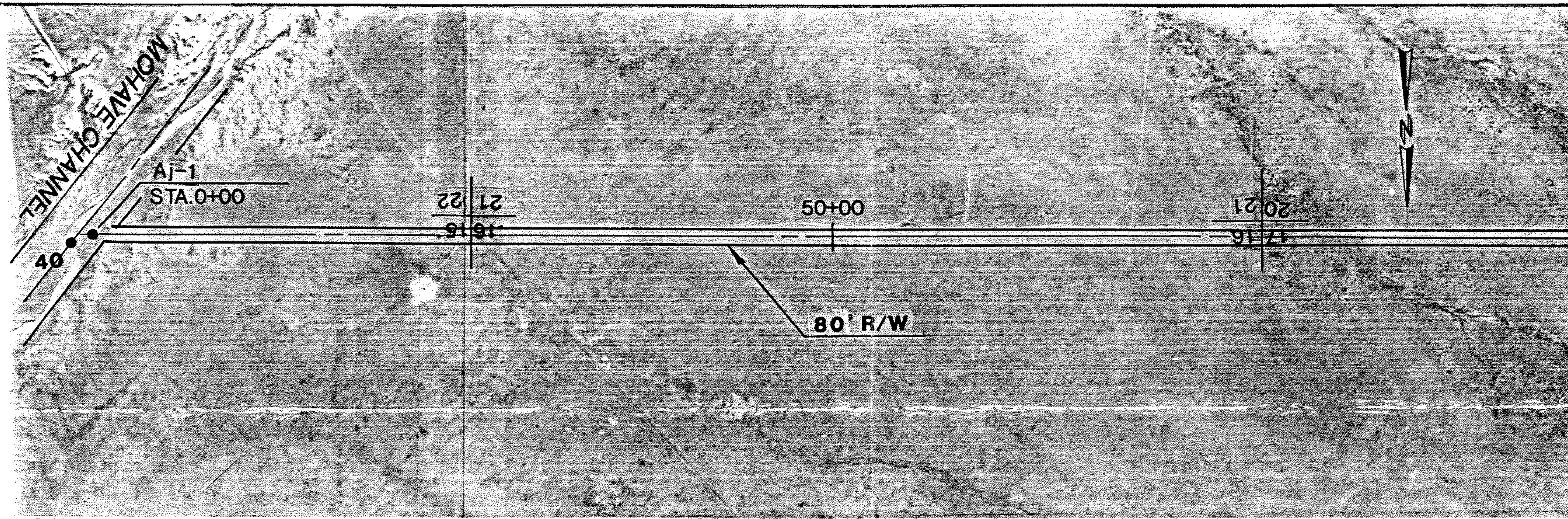
PLATE 25



SEE PLATE 26

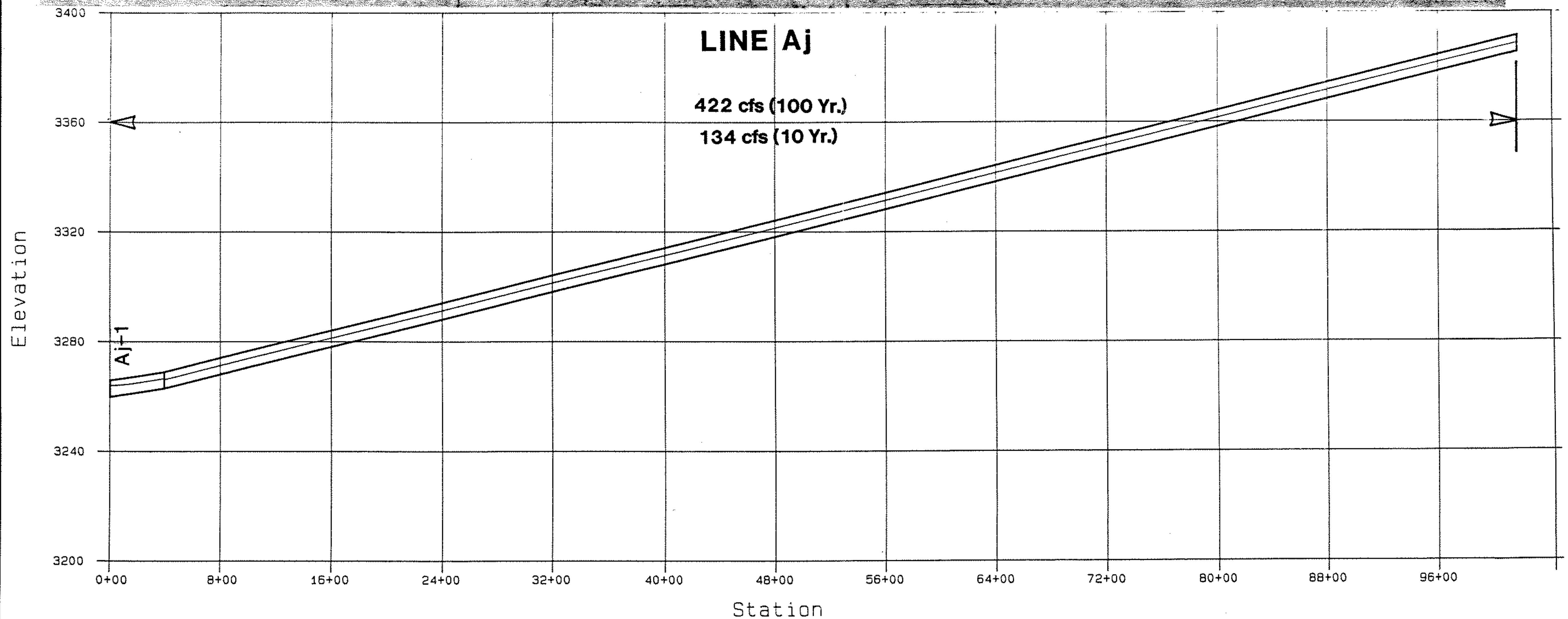


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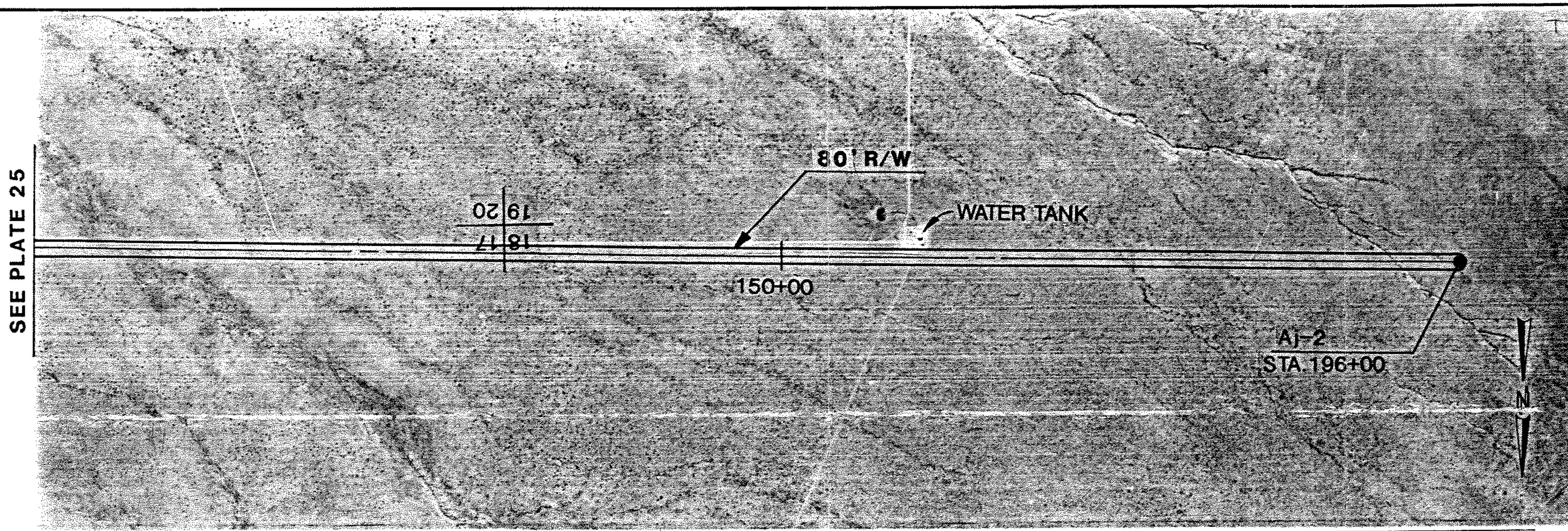
PLATE 26



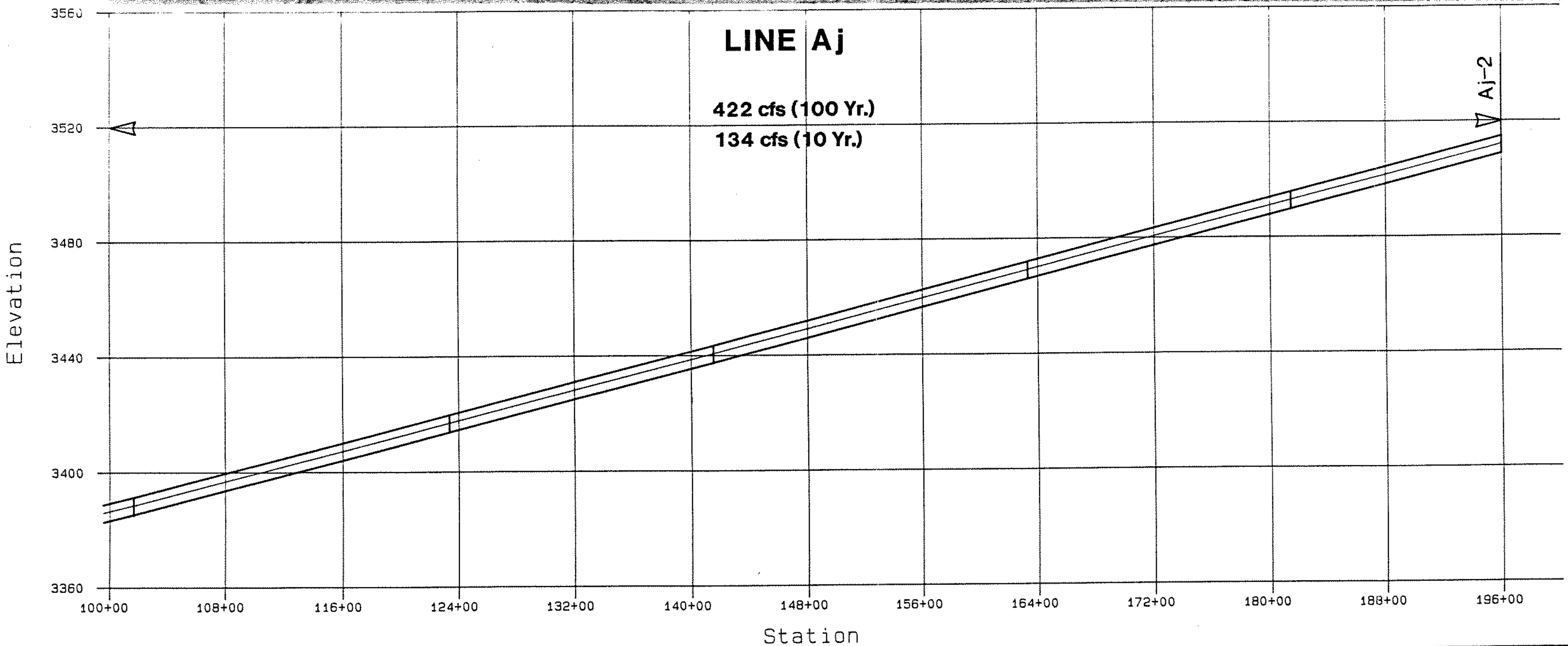


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PLATE 27


MOHAVE CHANNEL
MARSHALL DR.
JEFFERSON AVE.
N
Ak-1
STA.0+00
90' R/W
Ak-2
STA.72+00

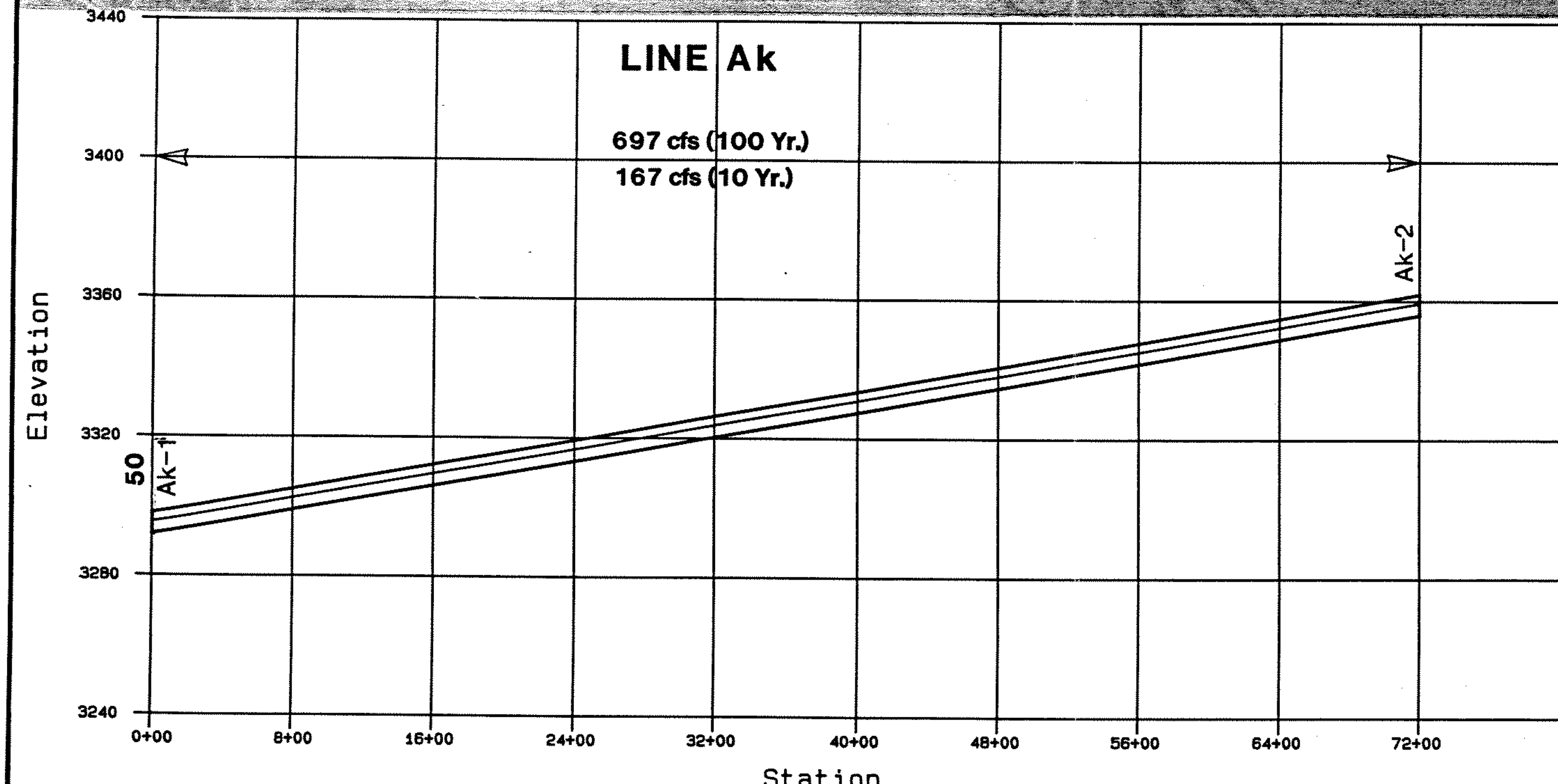
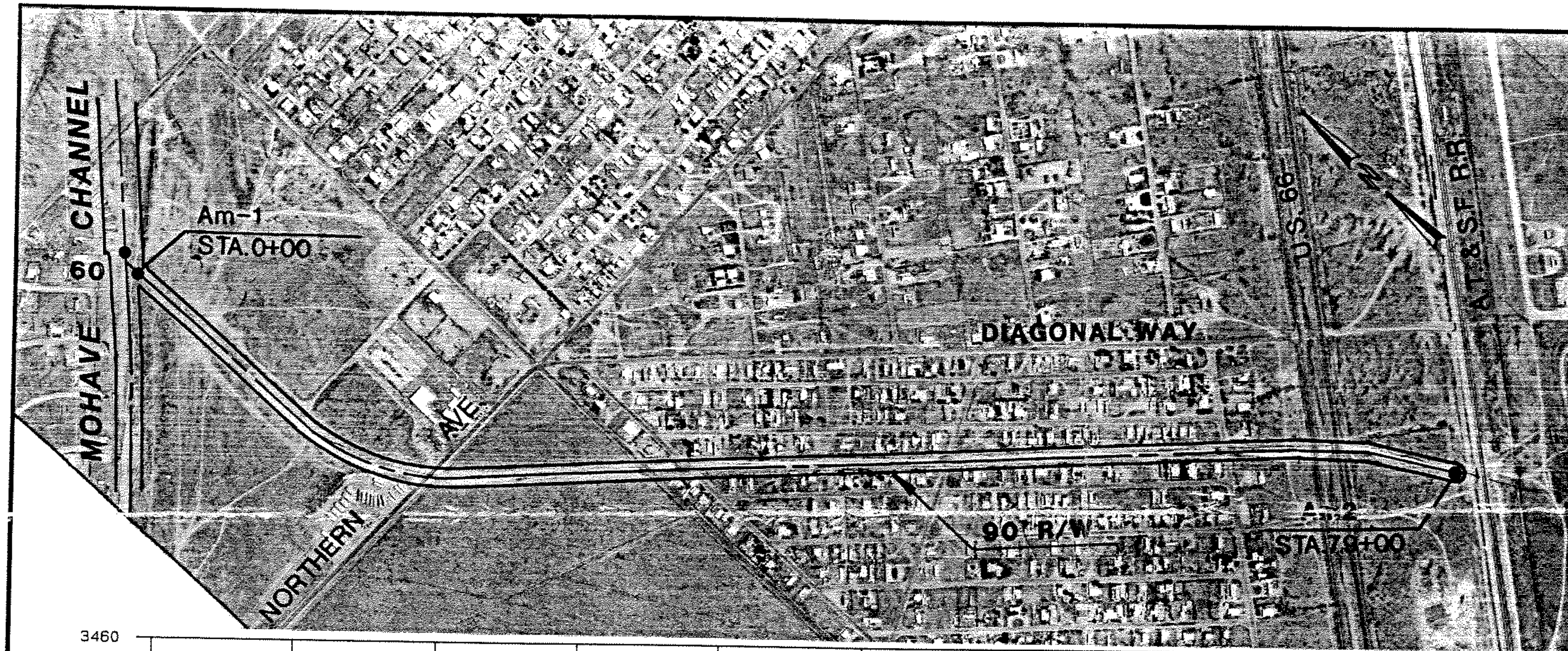
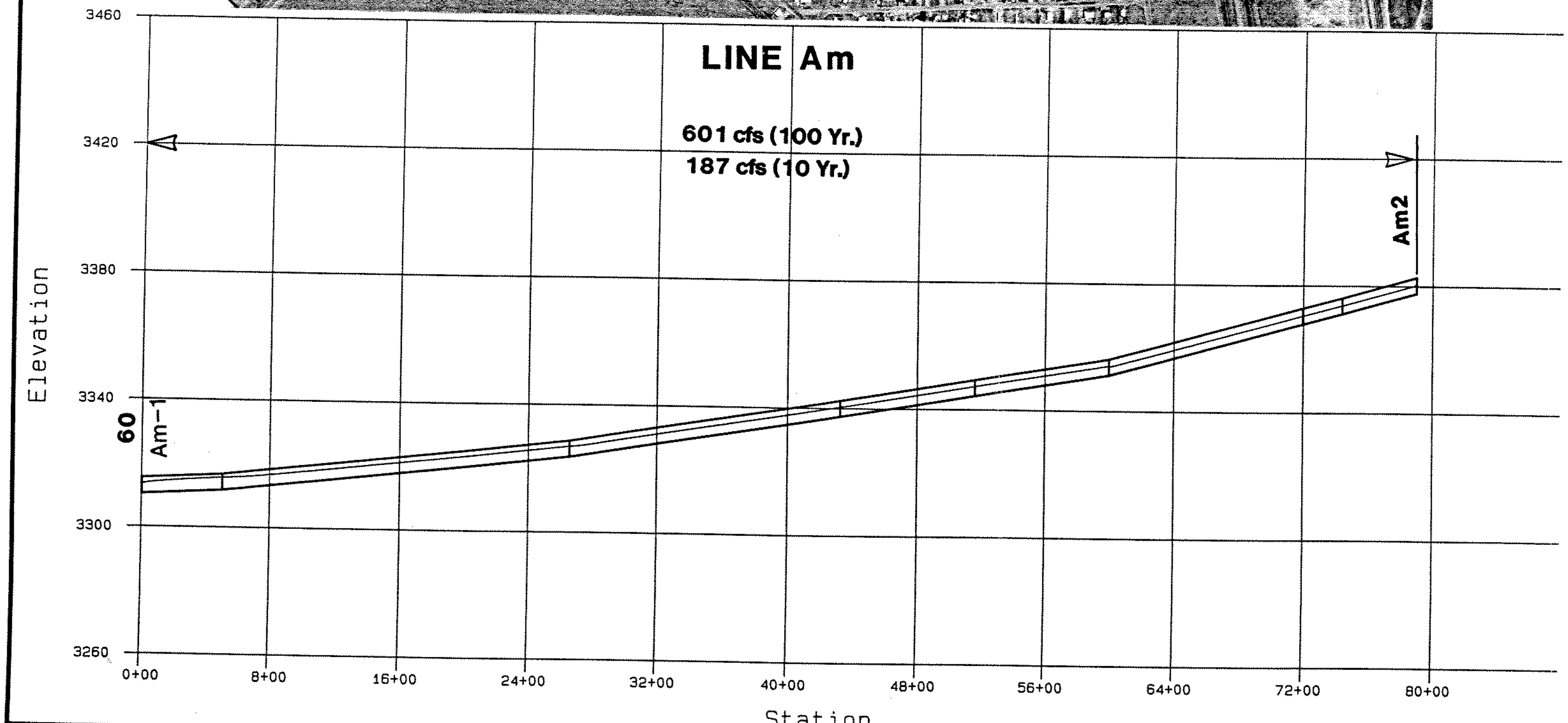

LINE Ak
697 cfs (100 Yr.)
167 cfs (10 Yr.)
Elevation
3440
3400
3360
3320
3280
3240
Station
0+00
8+00
16+00
24+00
32+00
40+00
48+00
56+00
64+00
72+00
Ak-1
Ak-2
50

PLATE 28



MOHAVE CHANNEL
60
Am-1
STA.0+00
DIAGONAL WAY
U.S. 66
AT & SF R.R.
N
NORTHERN AVE
90' R/W
Am-2
STA.79+00



LINE Am
601 cfs (100 Yr.)
187 cfs (10 Yr.)
Am2
60
Am-1
Elevation
3460
3420
3380
3340
3300
3260
0+00
8+00
16+00
24+00
32+00
40+00
48+00
56+00
64+00
72+00
80+00
Station

PLATE 29

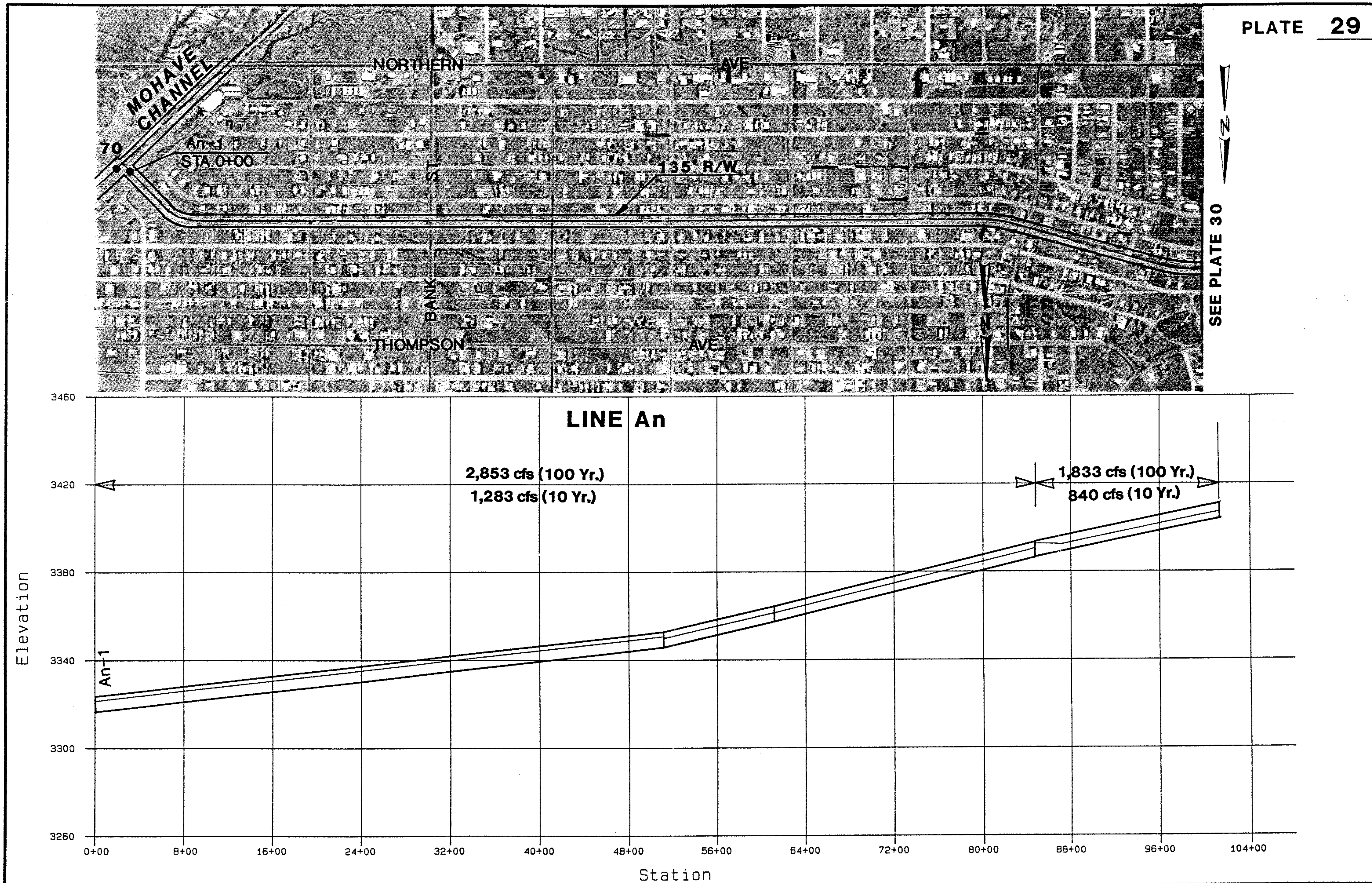
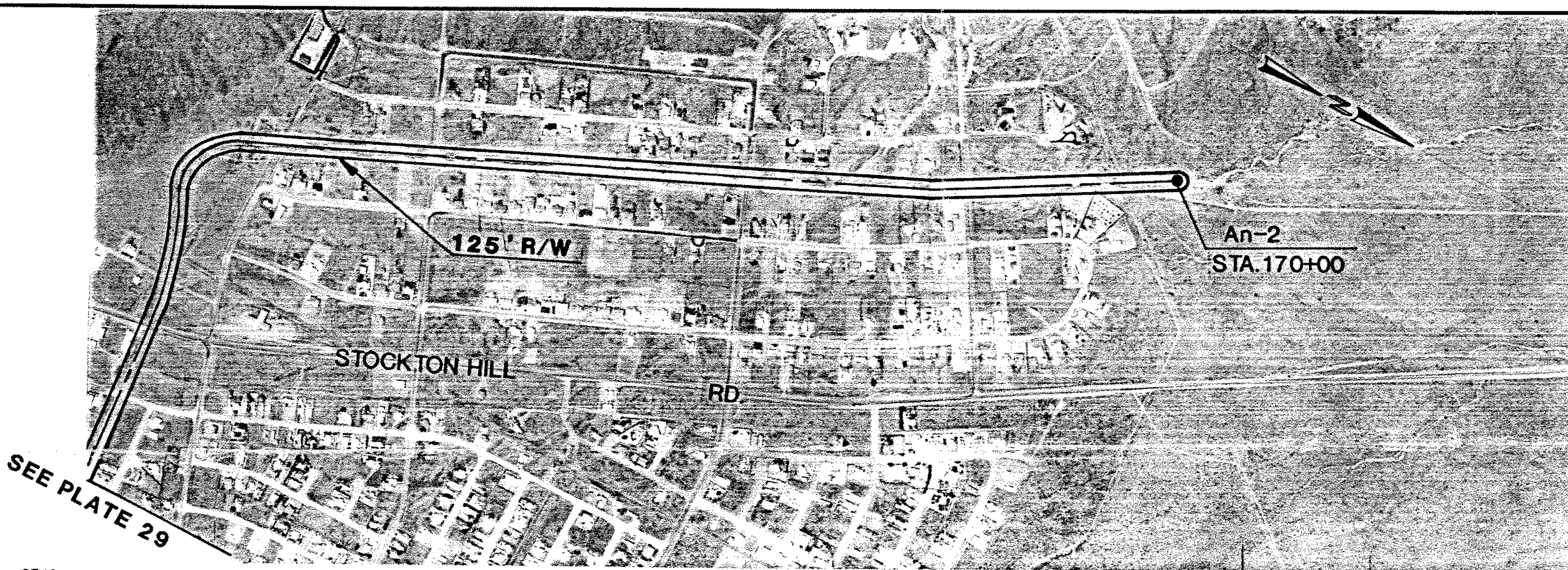

MOHAVE CHANNEL
NORTHERN AVE
70
An-1
STA.0+00
135' R/W
BANK ST
THOMPSON AVE
N
SEE PLATE 30
LINE An
2,853 cfs (100 Yr.)
1,283 cfs (10 Yr.)
1,833 cfs (100 Yr.)
840 cfs (10 Yr.)
Elevation
3460
3420
3380
3340
3300
3260
An-1
Station
0+00
8+00
16+00
24+00
32+00
40+00
48+00
56+00
64+00
72+00
80+00
88+00
96+00
104+00

PLATE 30



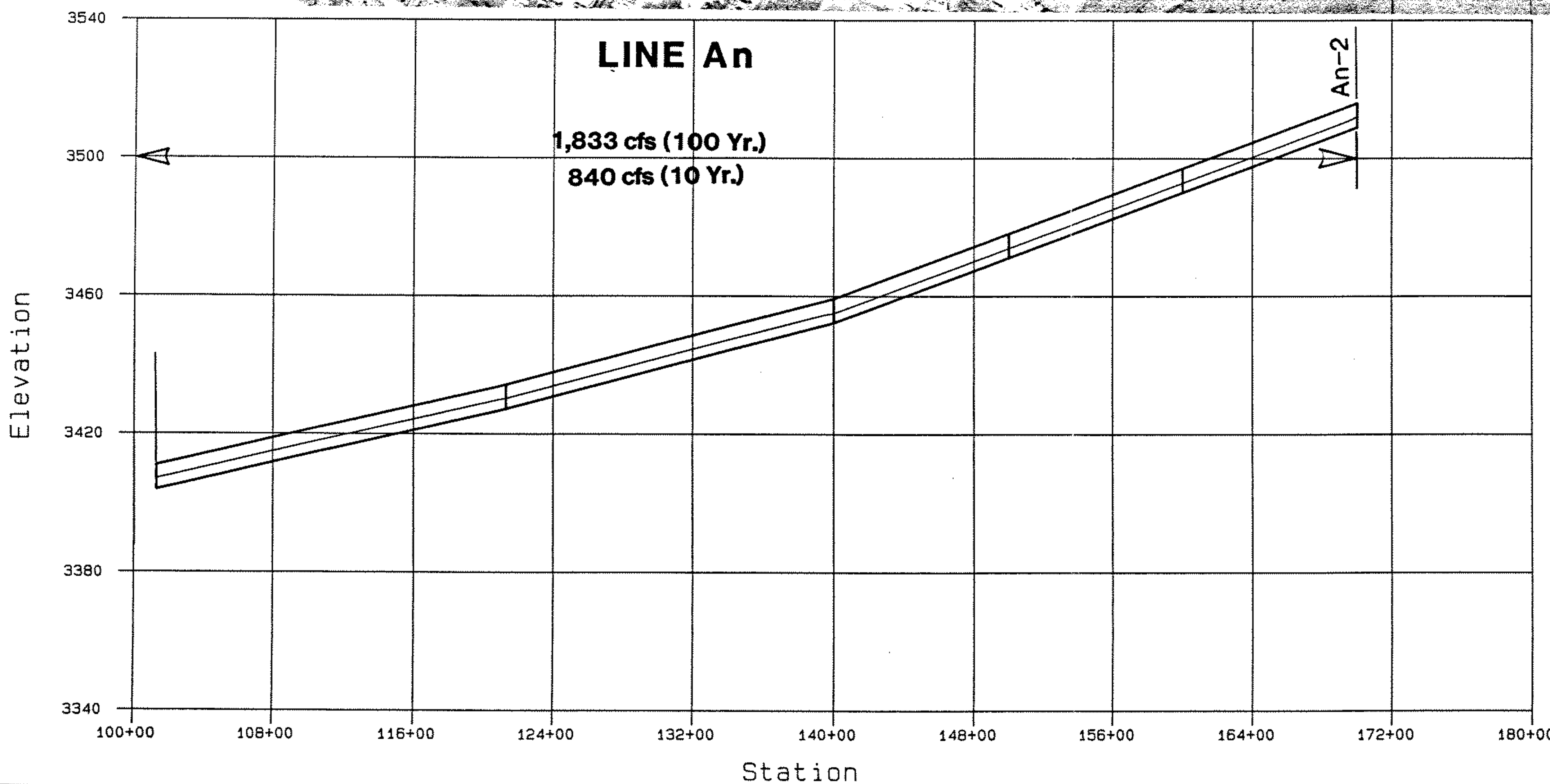


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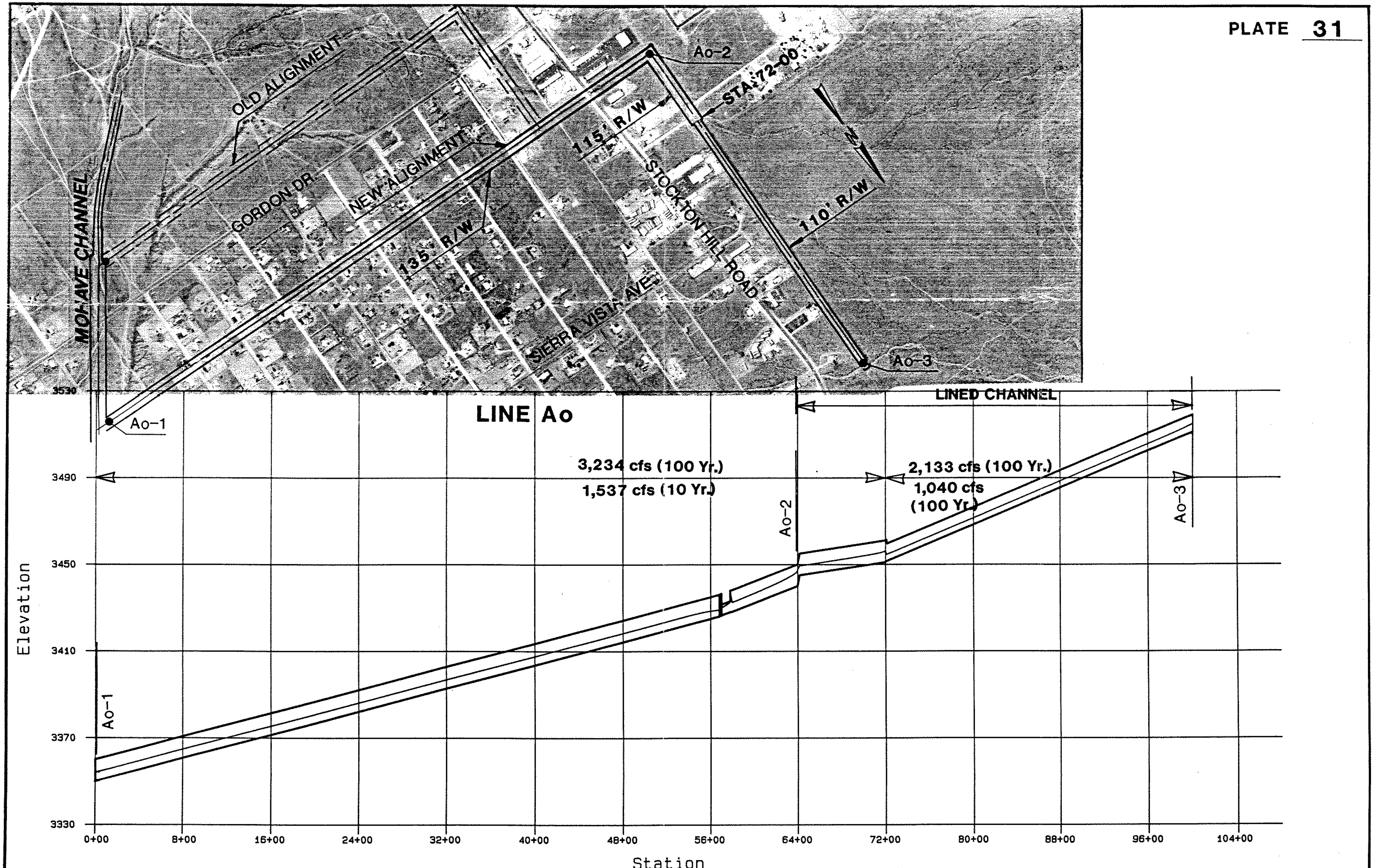
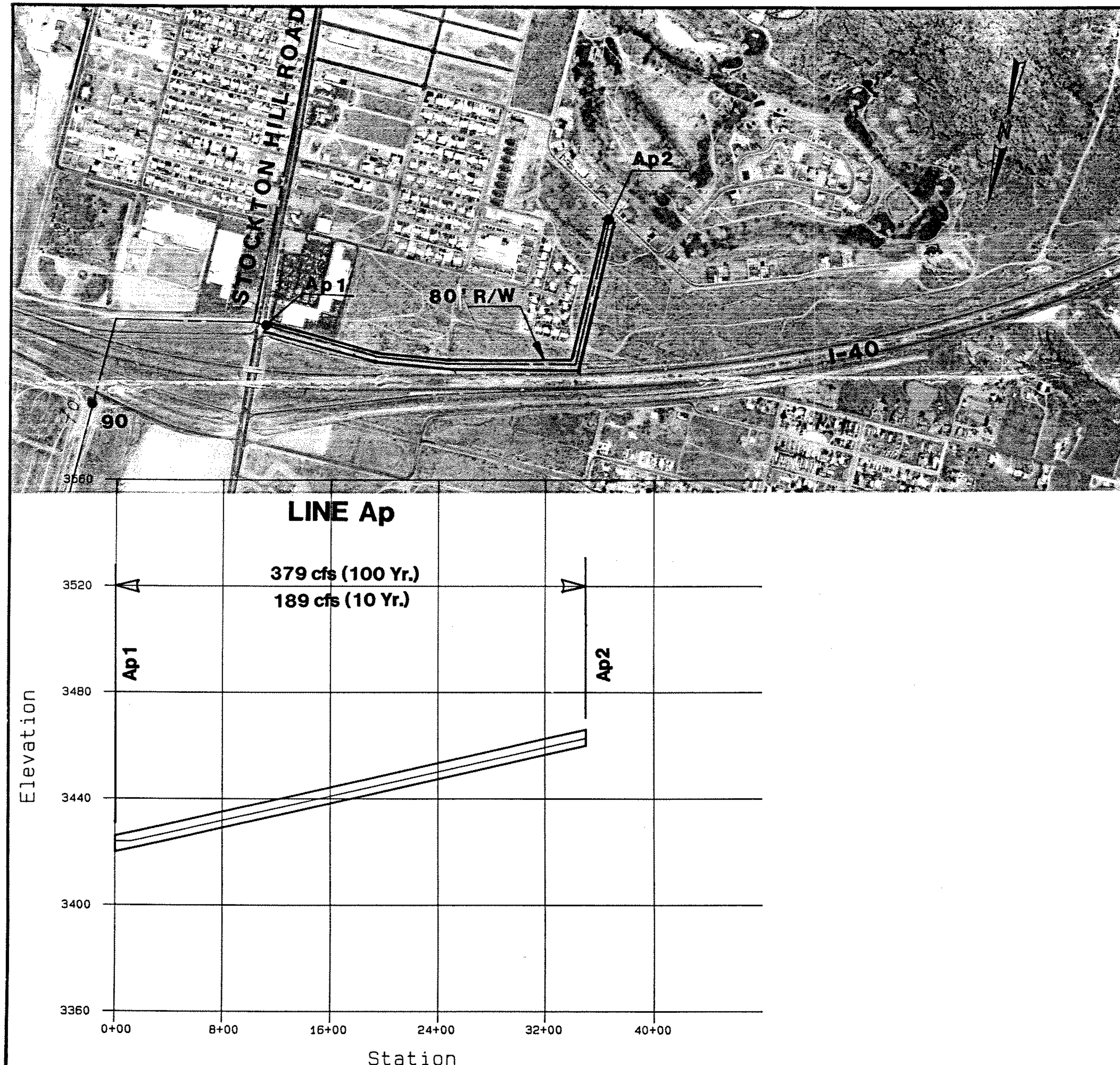
PLATE 31



OLD ALIGNMENT
Ao-2
STA. 72-00
N
115' R/W
GORDON DR.
NEW ALIGNMENT
MOJAVE CHANNEL
STOCKTON HILL ROAD
110' R/W
135' R/W
SIERRA VISTA AVE.
Ao-3
Ao-1
LINE Ao
LINED CHANNEL
3,234 cfs (100 Yr.)
1,537 cfs (10 Yr.)
2,133 cfs (100 Yr.)
1,040 cfs
(100 Yr.)
Ao-2
Ao-3
Ao-1
Elevation
3530
3490
3450
3410
3370
3330
0+00
8+00
16+00
24+00
32+00
40+00
48+00
56+00
64+00
72+00
80+00
88+00
96+00
104+00
Station

PLATE 32


STOCKTON HILL ROAD
Ap2
Ap1
80' R/W
I-40
90
LINE Ap
379 cfs (100 Yr.)
189 cfs (10 Yr.)
Ap1
Ap2
Elevation
3560
3520
3480
3440
3400
3360
0+00
8+00
16+00
24+00
32+00
40+00
Station

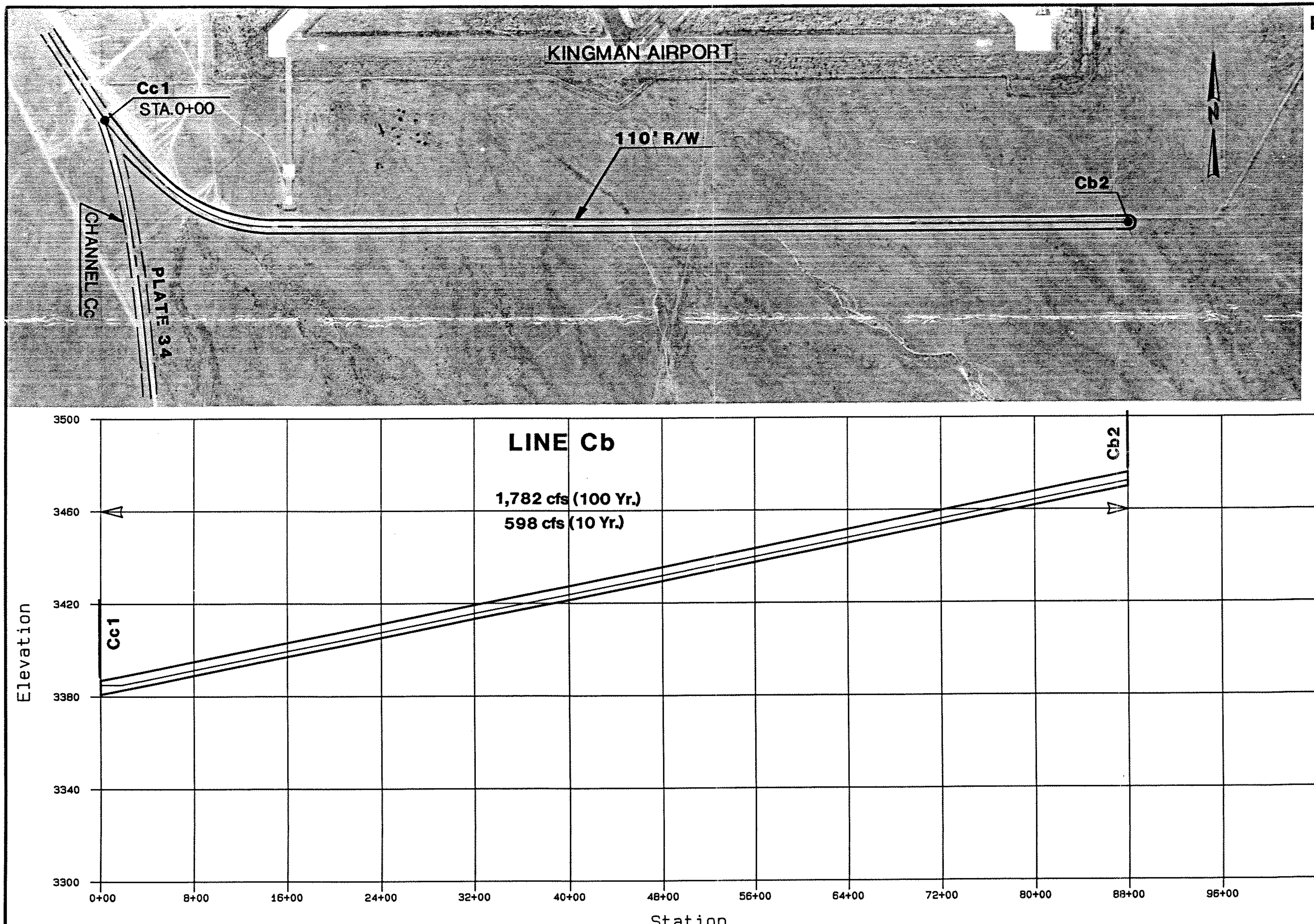


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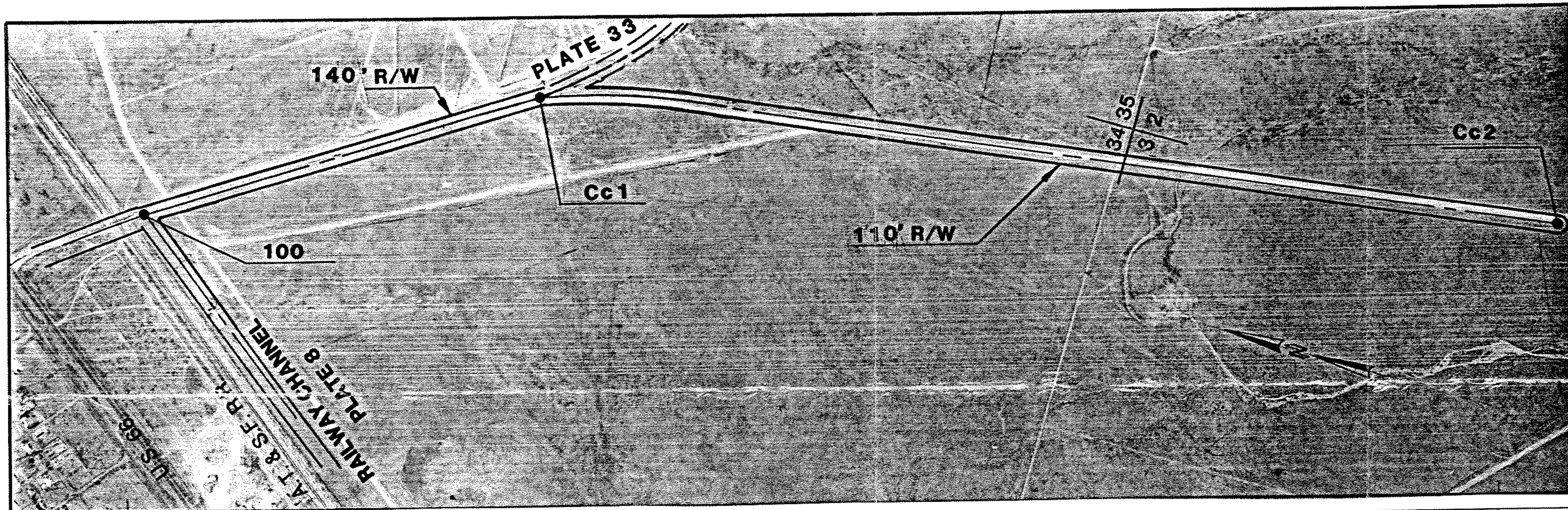
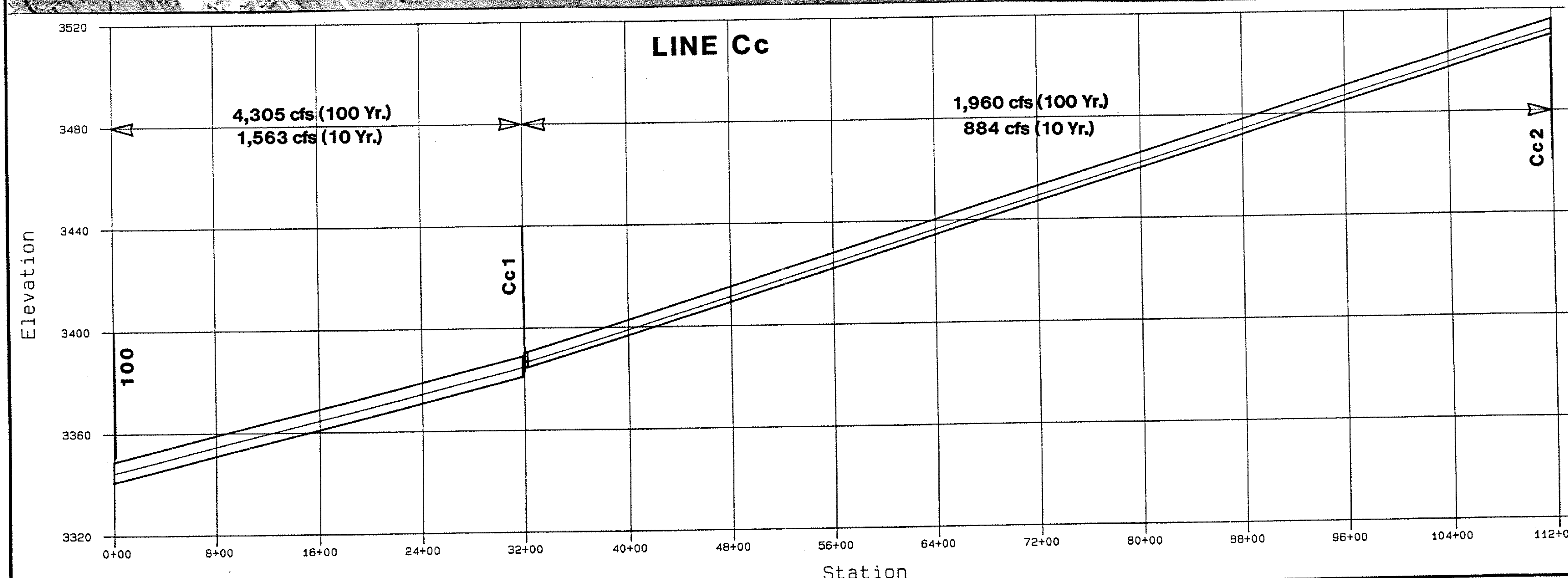
PLATE 34





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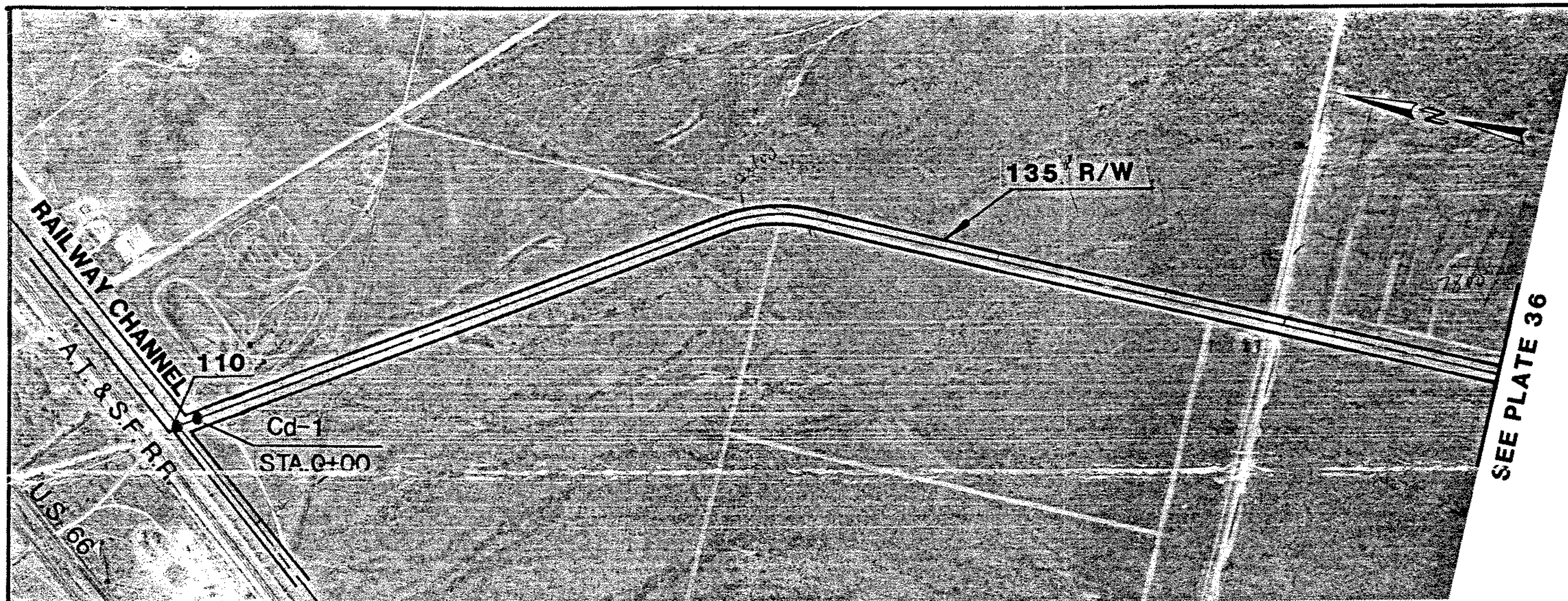

135' R/W
RAILWAY CHANNEL
110
Cd-1
STA.0+00
A.T. & S.F. R.R.
U.S. 66
SEE PLATE 36

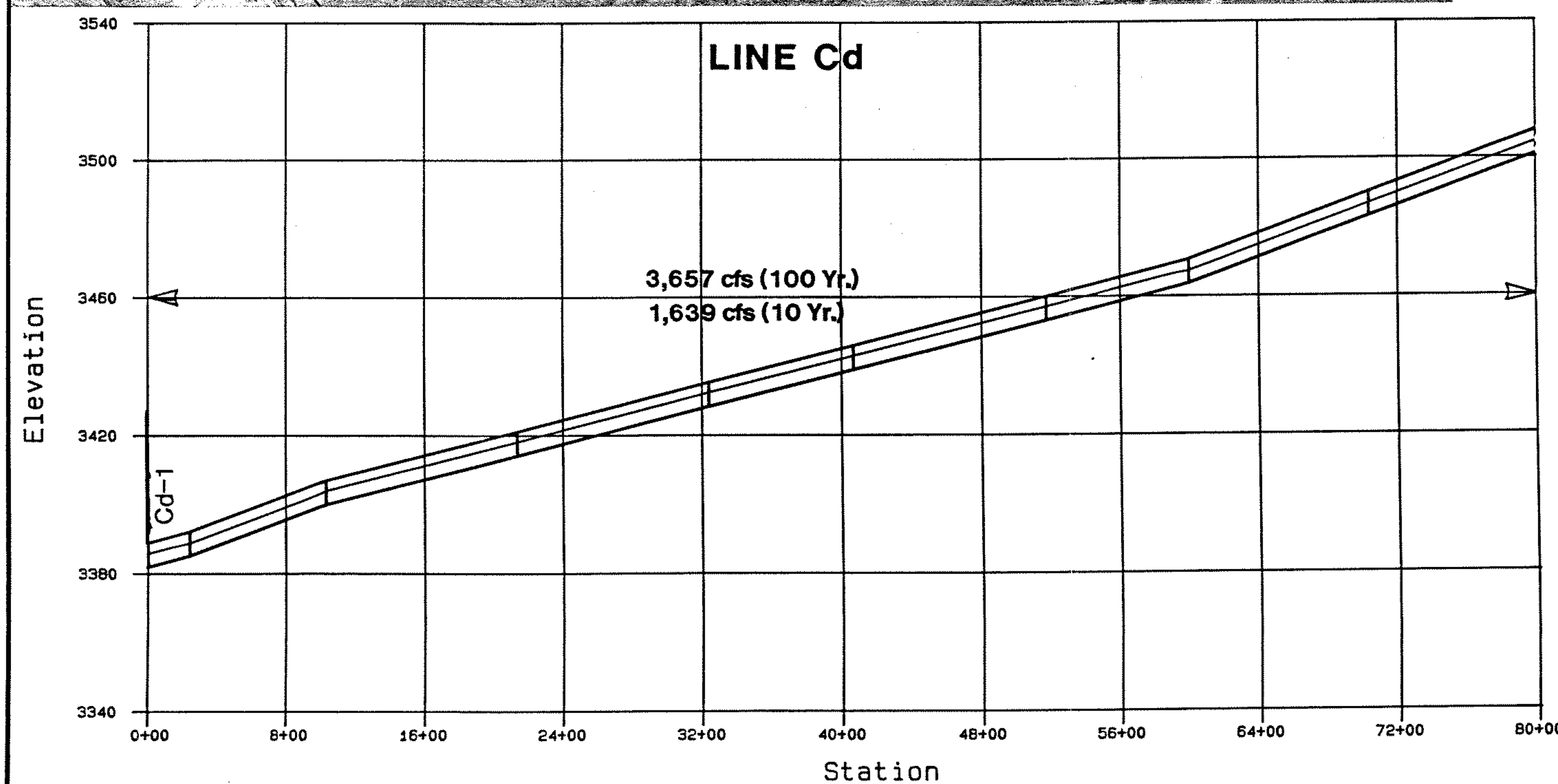
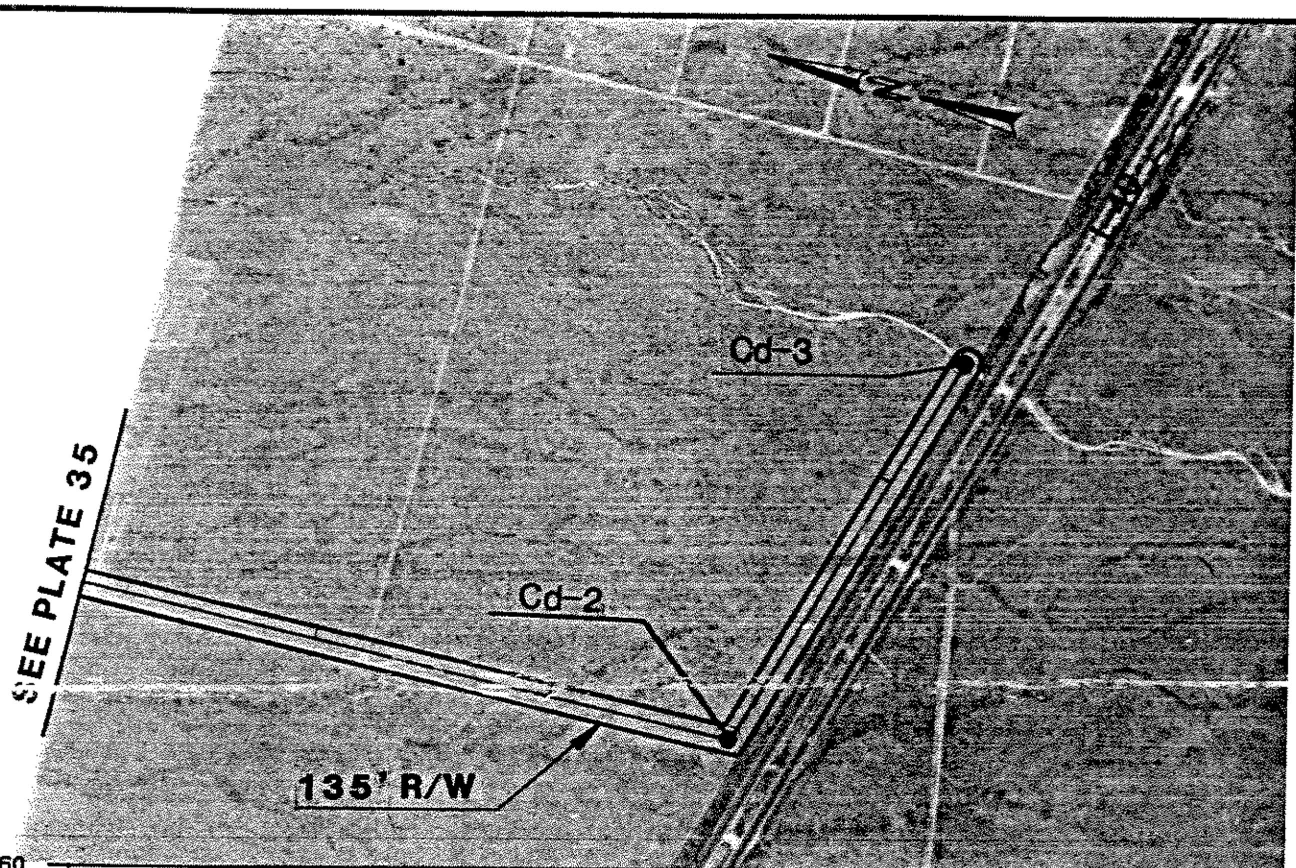
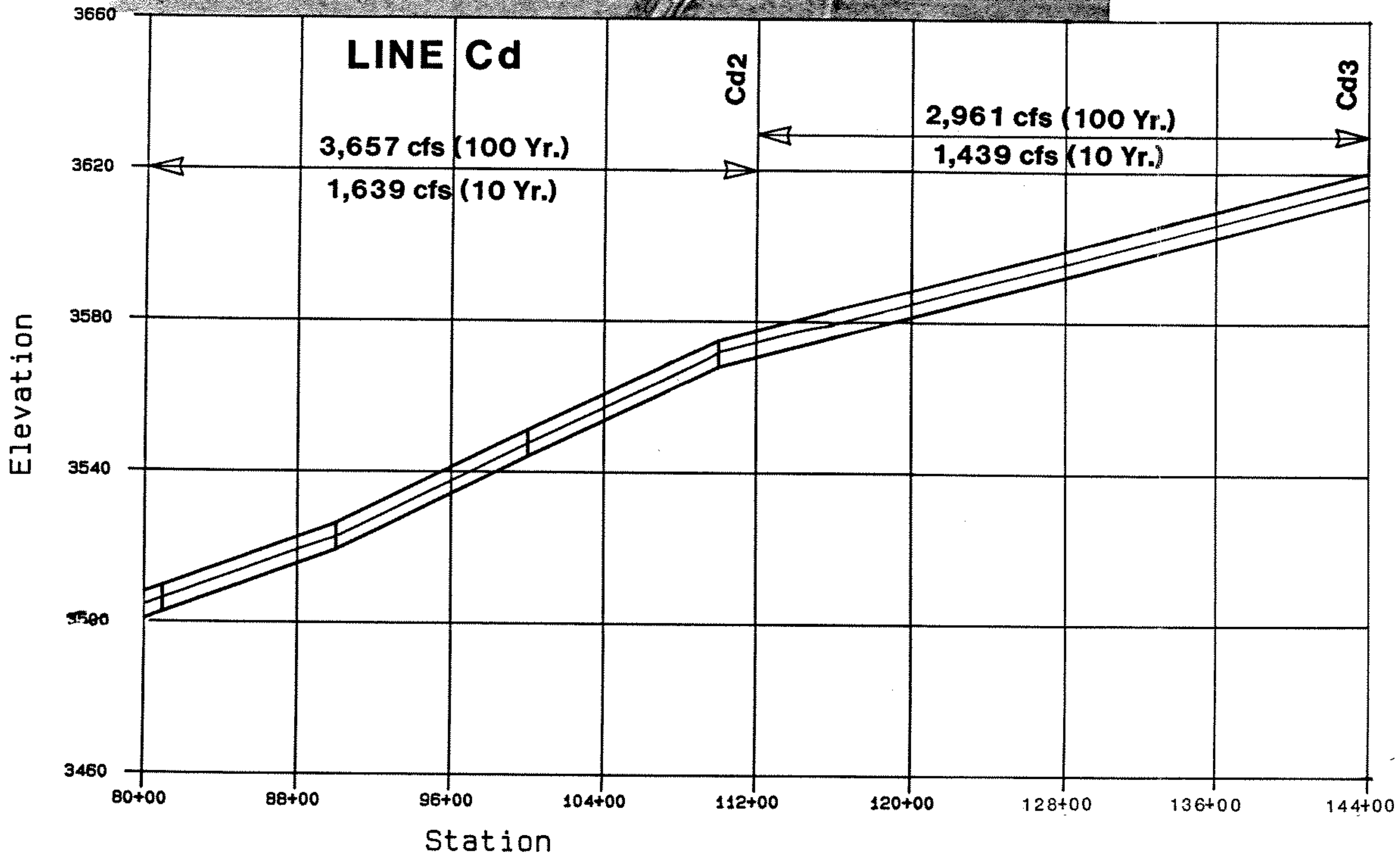

LINE Cd
3,657 cfs (100 Yr.)
1,639 cfs (10 Yr.)
Cd-1
Elevation
Station
3540
3500
3460
3420
3380
3340
0+00
8+00
16+00
24+00
32+00
40+00
48+00
56+00
64+00
72+00
80+00

PLATE 36

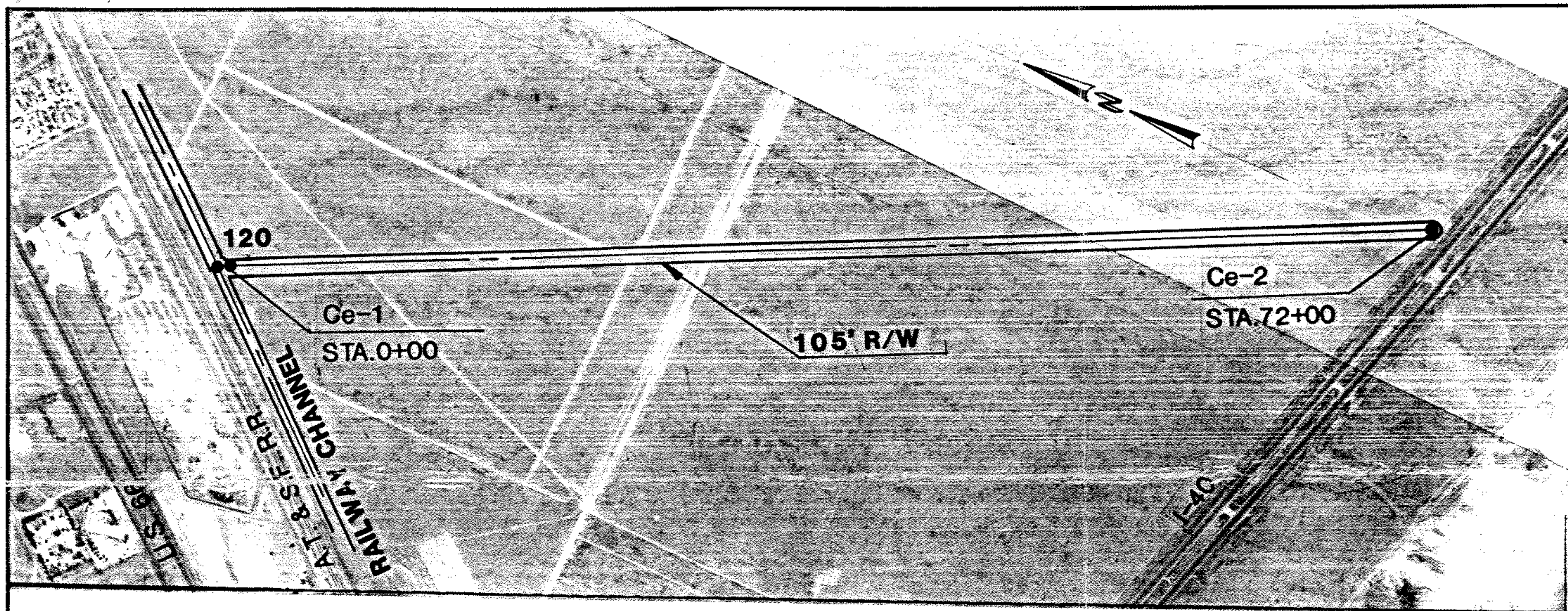


N
Cd-3
Cd-2
SEE PLATE 35
135' R/W



LINE Cd
Cd2
Cd3
3,657 cfs (100 Yr.)
1,639 cfs (10 Yr.)
2,961 cfs (100 Yr.)
1,439 cfs (10 Yr.)
Elevation
3660
3620
3580
3540
3500
3460
Station
80+00
88+00
96+00
104+00
112+00
120+00
128+00
136+00
144+00

PLATE 37



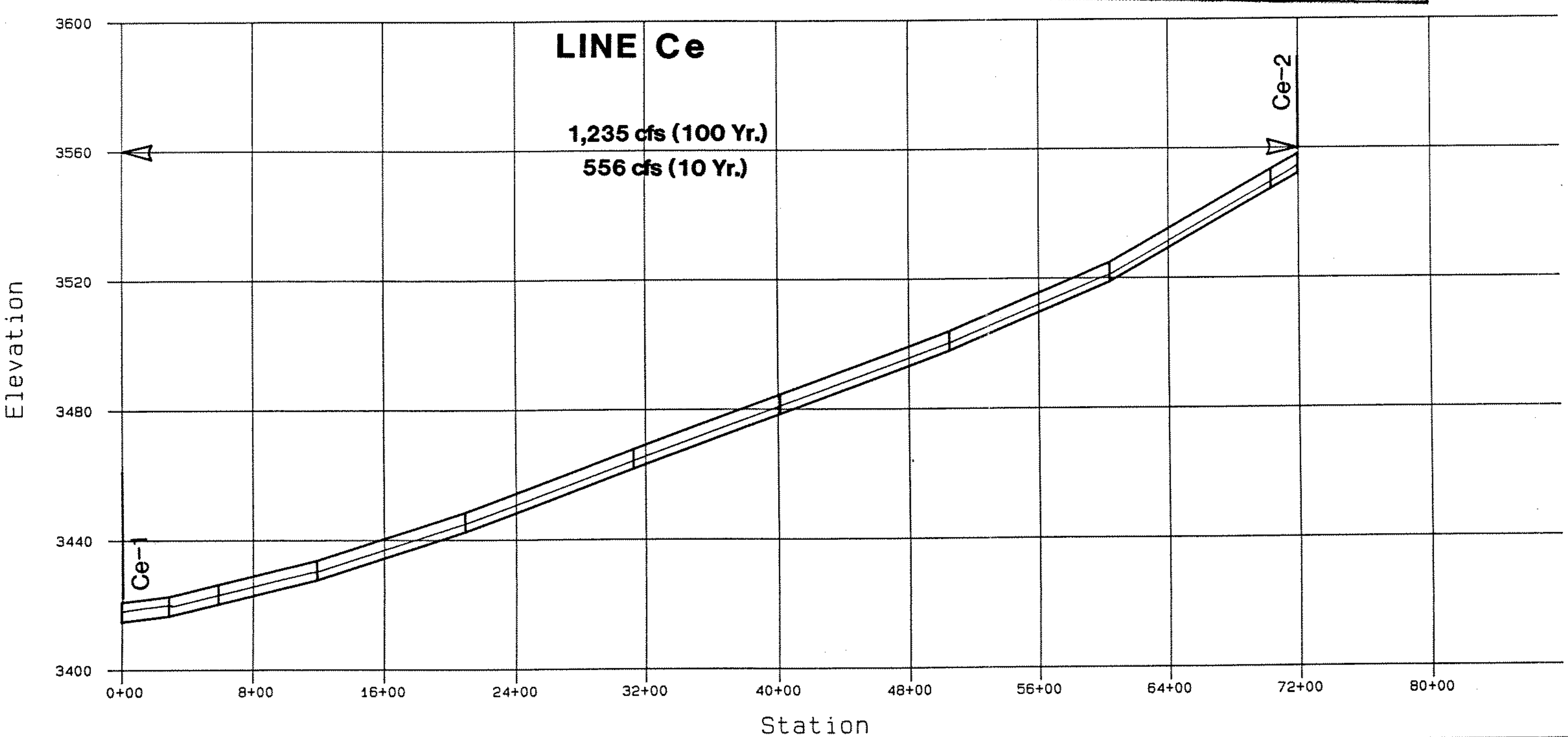


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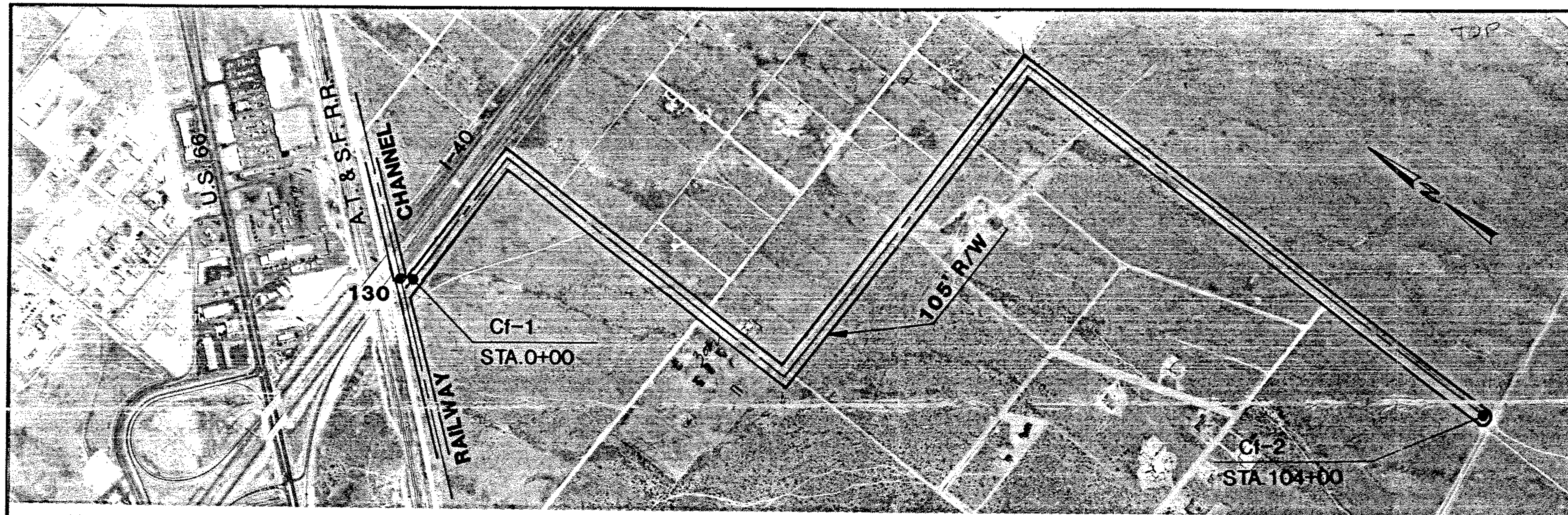
PLATE 38



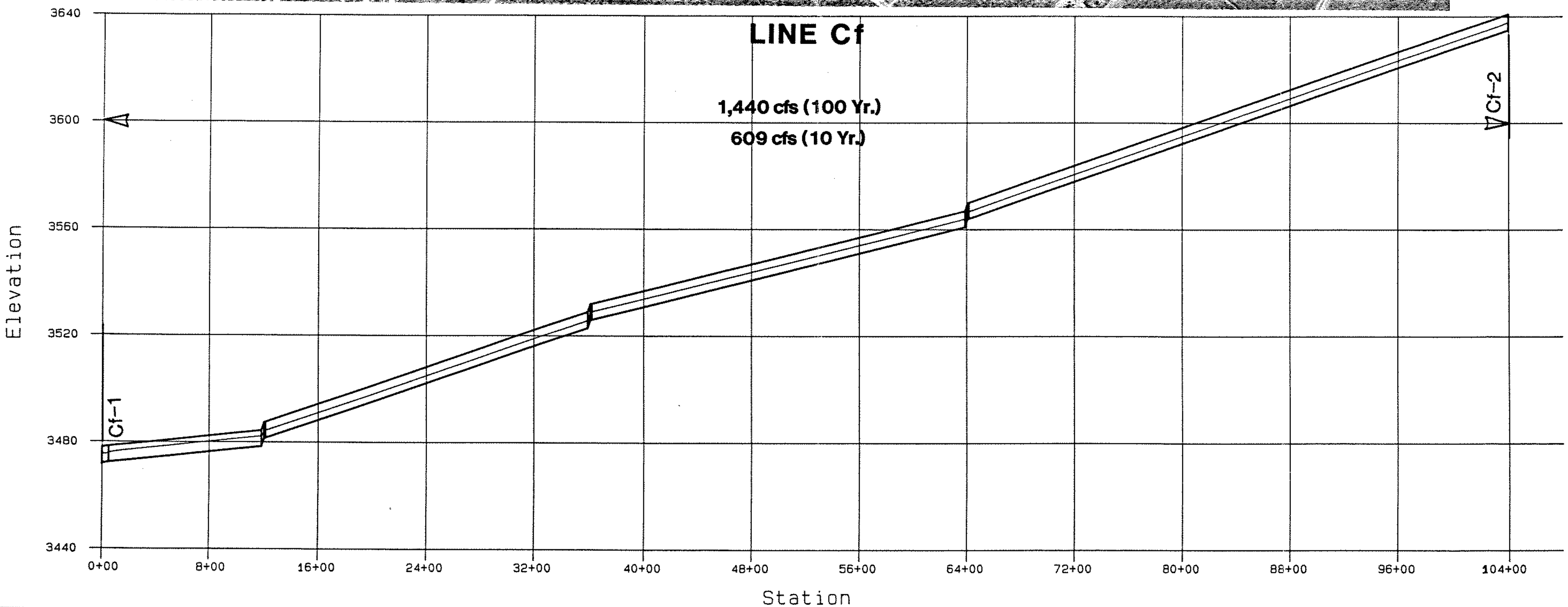


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PLATE 39

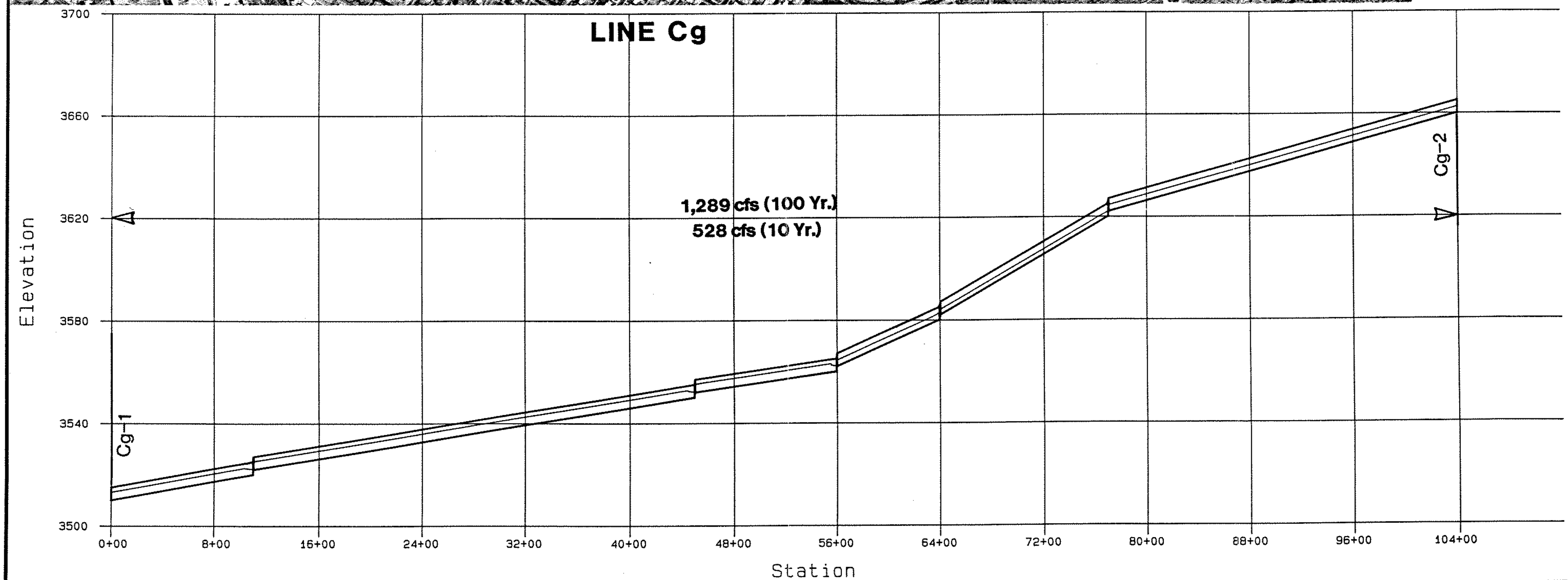

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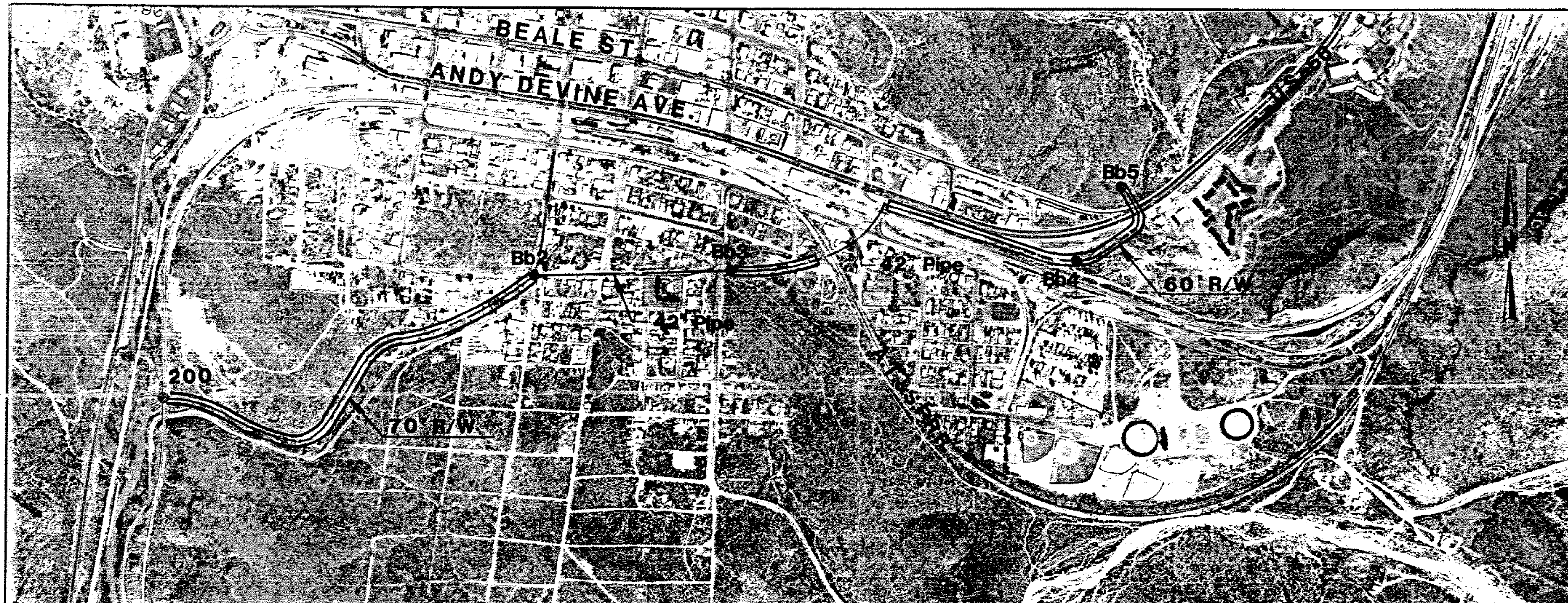
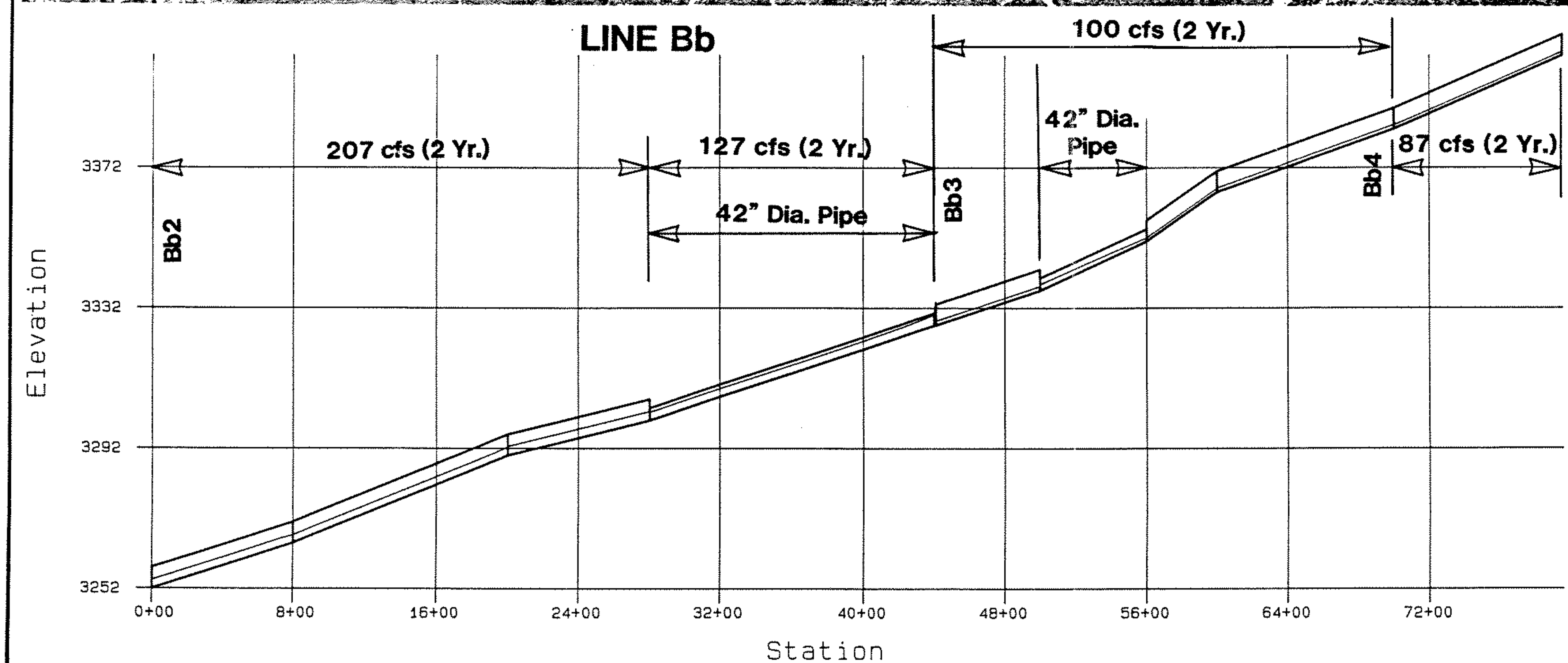
PLATE 40



BEALE ST
ANDY DEVINE AVE
Bb5
Bb2
Bb3
42" Pipe
Bb4
60' R/W
42" Pipe
200
70' R/W



LINE Bb
100 cfs (2 Yr.)
42" Dia. Pipe
207 cfs (2 Yr.)
127 cfs (2 Yr.)
87 cfs (2 Yr.)
42" Dia. Pipe
Bb2
Bb3
Bb4
Bb5
3372
3332
3292
3252
Elevation
0+00
8+00
16+00
24+00
32+00
40+00
48+00
56+00
64+00
72+00
Station